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Master Thesis

Exploring the Relationship between Wearables and FOMO on the Example of Smartwatches: A Qualitative User Study

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Zusammenfassung

Das Thema dieser Arbeit ist die bisher vernachlässigte Wechselbeziehung zwischen der Angst, etwas zu verpassen (FOMO) und der Nutzung von Smartwatches.

Im theoretischen Teil wurde eine Literaturrecherche durchgeführt, um FOMO zu konzeptualisieren und gleichzeitig zu diskutieren, ob das Konzept auf Smartwatches angewendet werden kann. Drei theoretische Ansätze, die am häufigsten im Zusammenhang mit FOMO verwendet werden, wurden identifiziert und eingehend behandelt: Die Selbstbestimmungstheorie (SDT), das Person-Affect-Cognition-Execution (I-PACE) Modell und die Compensatory Internet Use Theory (CIUT).

Im empirischen Teil wurden im Rahmen der qualitativen Studie vierzehn Nutzerinterviews durchgeführt, um Smartwatch-spezifische Verhaltensweisen im Zusammenhang mit FOMO zu analysieren. Die inhaltsstrukturierende Inhaltsanalyse wurde mit Hilfe der Software MAXQDA durchgeführt.

Die Arbeit liefert eine neue Klassifizierung von FOMO-Arten, die um die in der FOMO-Forschung bisher ignorierte Maschine-zu-Mensch-Interaktion erweitert wird. Außerdem wird das konzeptionelle Modell, das auf der Grundlage der am häufigsten verwendeten theoretischen Entitäten erstellt wurde und das die Wechselbeziehung zwischen der Nutzung von Smartwatches und FOMO strukturiert, getestet und kann in die weitere Forschung übernommen werden.

Die Studie leistet einen Beitrag, indem sie eine empirische Arbeit zu Wearables und insbesondere zu Smartwatches liefert, in der es eine Forschungslücke gab. Sie vertieft das Thema FOMO auf verschiedenen Geräten, eröffnet neue Bereiche für weitere Forschung und Diskussion und lenkt die Aufmerksamkeit von Designern und Nutzern auf das Problem.

Abstract

The topic of this paper is the previously neglected interrelationship between the fear of missing out and smartwatch usage.

A literature review was conducted to conceptualize FOMO and simultaneously discuss whether the concept can be applied to smartwatches. Three theoretical entities most frequently used in relation to FOMO are identified and addressed in-depth: Self-Determination Theory, Person-Affect-Cognition-Execution (I-PACE) model and Compensatory Internet Use Theory (CIUT).

In the empirical part, as a part of the qualitative study, fourteen user interviews were conducted to analyze smartwatch-specific behaviors in relation to FOMO. Content-structuring content analysis is conducted with help of MAXQDA software.

The paper provides a new classification of FOMO types that is broadened by the machine-to-human interaction previously ignored in the FOMO research. It also tests the conceptual model created based on the most frequently used theoretical entities that structures the interrelationship smartwatch usage may have with FOMO that can be adopted in further research.

The research contributes by providing an empirical work regarding wearables and specifically smartwatches where there was a gap, deepening the topic of FOMO on different devices, opening new areas for further research and discussion as well as drawing attention of both designers and users to the problem.

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1 Introduction

1.1 Problem

Nowadays, digital devices capture our attention more than ever as they are widely used in many aspects of everyday life and in professional spheres. In business studies the market is referred to as "attention economy" (Davenport and Beck 2001:17). The price of attention soars while different actors compete for our time; and the value of concentration increases as it becomes scarce. Every device and every application on it use all methods designed to draw our attention to itself. And while development of new technologies brings new opportunities, it also brings new challenges. This paper focuses on the latter, investigating possible negative effects of wearable devices, specifically smartwatches, on one's attention, and namely on fear of missing out.

There are two key concepts which play a role in the framework of this paper. The first one is fear of missing out (FOMO). Fear of missing out is "a pervasive apprehension that others might be having rewarding experiences from which one is absent" and is characterized "by the desire to stay continually connected with what others are doing" (Przybylski et al. 2013:1841). Fear of missing out is linked to excessive and problematic Internet usage, social network services usage and other addictive behaviors that have an impact on concentration, resulting in distracted and less focused daily experiences, impairing attention, interrupting school or work and other life activities (Elhai, Yang, and Montag 2021:204).

The second topic of high importance is the concept of wearable devices and specifically, smartwatches. On the one hand, this type of technology is gaining in relevance and popularity on the market. In year 2020, sales of wearables worldwide amounted to around 445 million units (IDC 2022), which was underpredicted a year before (IDC 2020). That year smartwatches contributed to 28 billion Euro worth of sales worldwide and this number is predicted to rise to 45 billion until 2026 (Statista 2022c). Worldwide around 203 million people were smartwatch users in 2021 and the countries with highest penetration rate of up to 17.6% were Norway, Luxemburg, New Zealand, Island and Switzerland (Statista 2022c). Even though Austria did not top the list, smartwatch sales reached 98 million Euro in 2021, with the penetration rate of 6% (Statista 2022b). On the other hand, smartwatches provide a variety of uses both in personal and academic spheres. For a commercial user, smartwatches fit into their device ecosystem and offer fast notification alerts from messaging services, a

variety of self-tracking functionality recording biodata and showcasing the findings as well as some other digital device functionality such as access to weather and music applications. In academic fields, problems in a wide range of disciplines are being studied and addressed with the help of smartwatches. From medical subjects, where smartwatches are used with the goal of fast and simple recording of patients' data in order to avoid unnecessary procedures, e.g., detecting heart conditions (Bumgarner et al. 2018:2381), to everyday topics where smartwatches can be used, for instance, for detecting driver drowsiness (Li, Lee, and Chung 2015:7169). The practicality lies in the employment of smartwatches for a variety of measurements. The sensorics enables activity recognition – and not only movement in the form of walking, as a smartphone can, but also hand-oriented activities such as clapping, brushing teeth, typing and eating different types of food (Weiss et al. 2016:427). Besides that, smartwatches can, for example, be employed for emotion recognition, as the way a person walks can reflect that person's current mood - or emotional state (Quiroz, Geangu, and Yong 2018:3).

In previous research, FOMO was investigated in connection with staying in touch with the help of smartphones, however, smartwatches enable the same connectivity even closer – on a "haptic instant" (Gilmore 2017:191). Meaning that social media applications as well as self-tracking applications are directly available, and notifications physically nudge engagement.

The aim of this research is to investigate, whether and how the FOMO concept is applicable in relation to wearables and examine the relationship between this concept and smartwatches. There is a gap in existing research on the topic of FOMO in relation to digital devices other than smartphones. Therefore, the purpose of the following paper is to examine whether the findings about FOMO can also be transferred to smartwatches and smartwatch users. The focus of the research lies in exploration of behavioral modifications, with an accent on psychological dynamics of the phenomenon.

The relevance of this research consists of two combined factors: the increasing spread of smartwatches and findings linking FOMO to such significant consequences as social media addiction (Blackwell et al. 2017) and consequently through the compulsory social media use to social media fatigue, which later results in elevated anxiety and depression (Dhir et al. 2018). The negative affect of FOMO includes distraction, loss of focus, and regret

(Milyavskaya et al. 2018:734), that can negatively influence physical, emotional, and cognitive health (Baker, Krieger, and LeRoy 2016:280).

The contribution of this research is fourfold. Firstly, empirical work regarding wearables and smartwatches in particular is scarce. While the interplay of smartphones and social media services with FOMO has been an acute topic over the recent years (e.g. Blackwell et al. 2017; Wolniewicz et al. 2018), the interrelation between wearable technologies and FOMO is hardly explored. Studying the effect of smartwatches on FOMO and vice versa will broaden the field, deepening the knowledge about the wearable devices.

Secondly, based on the facts mentioned above – the absence of precedented examination of FOMO in the dimension of wearable devices, the following research will also contribute to the research field of FOMO and broaden the knowledge of the matter.

Thirdly, FOMO is a part of problematic behavior that is linked to a decrease of quality of life. Research on FOMO will contribute to the awareness of both designers and users.

Lastly, it is claimed that the commercial goal for the companies is to bind users with the continued use of smartwatches. At the same time, habit plays an important role in affecting a user's intention to continue using a smartwatch (Nascimento, Oliveira, and Tam 2018:165). Nowadays FOMO can be utilized as a part of a marketing strategy in commercial advertising appeals to initiate sales (Hodkinson 2019:65), which makes the topic increasingly problematic from the ethics perspective. Researching whether smartwatches influence fear of missing out in users will open new areas for further research and discussion, including ethical implications that are practical for smartwatch and smartwatch application designers and developers.

This paper takes a multidisciplinary approach, drawing on literature from addictive behaviors studies and medical research, information management, human computer interaction studies and computers in human behavior studies.

1.1.1 FOMO

This section provides a summary of findings about FOMO in the existing research to create an outline of the topic before investigating the subject and examining the applicability of the FOMO concept for wearable devices further in this paper.

As introduced above, FOMO is defined as "a pervasive apprehension that others might be having rewarding experiences from which one is absent" and is characterized "by the desire to stay continually connected with what others are doing" (Przybylski et al. 2013:1841). However, FOMO is more than simply a matter of exerting self-control to continue in a required activity at the expense of another more interesting one (Milyavskaya et al. 2018:734).

Fear of missing out is a construct that describes the tendency to feel disturbed or anxious over missing out some rewarding experiences others might be having. FOMO can manifest itself on every level of media use: early adopters of technology can among others be driven by the fear to miss out on an upcoming trend or an innovation; certain social media and messaging platforms can get popularized by fear of missing out on the platform-specific content and communication – creating network effects; and finally, FOMO can be driving social media use in order to stay connected to what others are doing.

FOMO gained special discourse in the online-specific context. That can be explained by the fact that, on the one hand, online communications applications allow fast sharing of trending activities that may motivate users to feel the need to participate in these activities. On the other hand, online communications applications become the subject of FOMO themselves when users feel a constant need to utilize the application not to miss out on content (Dhir et al. 2018:35).

However, other scholars argued that "FOMO experienced in the context of social media was the same as FOMO experienced through direct social contact" (Milyavskaya et al. 2018:733) and people experience FOMO independently of how they found out about it. Social media simply increases the likelihood for people to find out about the alternative activities. In addition to that, higher levels of FOMO lead to the use of a wider variety of social media platforms more frequently (Franchina et al. 2018:13), turning this into a vicious cycle.

Literature suggests that FOMO is a social phenomenon (Adams et al. 2017:343) as people experience less FOMO when they are engaging in an activity with another person, and more FOMO when the alternative activity is social in nature (Milyavskaya et al. 2018:734). FOMO is strongly linked to the need to belong, and the need of inclusion (Lai et al. 2016:519).

As previously indicated, FOMO is assessed as a phenomenon with links to negative aspects of digital technology or social media and Internet use specifically. FOMO is found to be related to problematic smartphone use as well as problematic social media use (Wolniewicz et al. 2018:622). It has been found that FOMO drives social media use based on fulfilling the social needs of belonging and simultaneously increases perceived stress during social media use (Beyens, Frison, and Eggermont 2016:6). FOMO predicted social media use and addiction above and beyond personality traits and attachment style (Blackwell et al. 2017:71). FOMO also correlates positively with social media's impact on daily life and productivity at work. Additionally, FOMO was positively correlated with SNUDs (social networks use disorders), including Facebook, Instagram, Snapchat and WhatsApp, which in turn affect the extent of social media's impact on life and productivity (Rozgonjuk et al. 2020:6). Additionally, FOMO indirectly results in social media fatigue via compulsive social media use (Dhir et al. 2018:148).

Furthermore, findings show that the effects of FOMO go over and above social media use alone, negatively influencing physical, emotional, and cognitive health (Baker et al. 2016:280). People with a greater fear of missing out experienced more physical symptoms, more depressive symptoms, and less mindful attention. FOMO was found to influence self-esteem in the relationship with SNS (social network sites) use and drive the capacity to experience online vulnerability that in turn lead to a decrease in welfare (Buglass et al. 2017:254). FOMO is also in the way of general well-being, causing poor learning approaches (Alt and Boniel-Nissim 2018:35) and impaired sleep (Adams et al. 2017:344–45) in pursuit of social interactions for students, as well as phubbing behavior – meaning that students are more likely to use social media during conversations with others present (Franchina et al. 2018:14).

Literature does not assign FOMO to be a single personality trait but rather a construct of dispositional characteristics and situational response (Dhir et al. 2018:35). Several factors influence the manifestation of FOMO, including boredom proneness, and though indirectly, anxiety (Elhai et al. 2020:302) and depression (Holte and Ferraro 2020:7). Moreover, FOMO "has been linked to the personality trait of neuroticism, one of the most well-known risk factors for developing a mood disorder. Furthermore, narcissism likely plays a role in FOMO" (Elhai et al. 2021:206). Dhir et al. (2018) divide FOMO in trait-based and online-specific state-based FOMO, assuming that FOMO can "be considered a dispositional trait in

terms of a relatively stable individual characteristic and as the general fear of an individual of missing out on something" (Dhir et al. 2018:35), but also be developed or triggered in specific contexts, e.g., of Internet communication. The latter is less stable and refers specifically to the increase of general trait-FOMO caused by, e.g., Internet-communication applications that produce and push a constant stream of updates and exchanges.

Fear of missing out is an important factor in understanding humans' relationship with technology and social media. Baker et al. (2016:280) call it an "informative metric" which helps understand the outcome related to media use. FOMO is claimed to have a role in the development of negative consequences of maladaptive technology use and mediating between psychopathological symptoms and negative consequences of social media use (Oberst et al. 2017:57). FOMO was shown to be the difference between problematic and non-problematic use, which in turn is associated with more depressive symptoms (Elhai et al. 2016:513). However, "[i]t is not yet clear whether FOMO causes negative affectivity, whether negative affectivity causes FOMO, or whether there is a bidirectional effect" (Elhai et al. 2021:206). Findings suggest bidirectionality between FOMO and problematic smartphone use (further as PSU), meaning the association between FOMO and PSU might not be due to the causal effects of either (Lo Coco et al. 2020:5).

FOMO is often studied among adolescents (Alt and Boniel-Nissim 2018; Beyens et al. 2016; Franchina et al. 2018; Lo Coco et al. 2020; Oberst et al. 2017) and specifically among students (Adams et al. 2017; Alt 2015, 2017, 2018; Alt and Boniel-Nissim 2018; Hetz, Dawson, and Cullen 2015), as this group is considered to be especially sensitive towards FOMO and have a higher risk of suffering from anxiety when they are missing out on important shared experiences (Oberst et al. 2017:57).

Women and more anxious individuals are more inclined to have higher initial negative affect ratings (Elhai et al. 2020:302). It is also supposed that „the FOMO construct might have a slightly different meaning and interpretation for women than men" (Elhai et al. 2018:296).

FOMO can be abused in multiple contexts, for example, on an individual level, when social media users publish enviable content to induce FOMO in others (Hetz et al. 2015:269), but also in commercial purposes with the goal of marketing (Hodkinson 2019:65).

To manage FOMO, a FOMO Reduction (FOMO-R) approach was proposed, suggesting some countermeasures to each facet of FOMO (Alutaybi et al. 2020:3–8). FOMO-R was

anticipated to help people to effectively manage their FOMO by creating awareness among them about how FOMO happens on social media and how it can be managed by adopting different countermeasures which can be either technical or social in nature. FOMO-R has five stages, each of them consisting of a set of strategies to guide change including such technical elements as autoreply, filtering, status as well as self-reflection and self-evaluation. Even though the findings had shown that FOMO-R had a significant result, and the majority of participants had a positive attitude towards these aspects after using FOMO-R, it is still a complex approach that seems overwhelming at first, requires some motivation (that was provided by external rewards within the research) and is not easily adopted because of the external pressure (Alutaybi et al. 2020:22). Therefore, even though research in the direction of FOMO reduction can provide valuable tools, it has not yet delivered a simple solution one could apply on an everyday basis.

The surveys in Austria on the topic of FOMO are rather limited. However, the results of, for example, Austrian Internet Monitor (AIM) show that 47% of questioned population agreed that constant engagement with a smartphone is driven by fear to miss out on something (INTEGRAL 2017:n.a.). 18% of those surveyed made a statement on phubbing and said they were perfectly capable of concentrating on a conversation with other people while answering messages on their smartphone or mobile phone. Lastly, 13% made a remark on their own FOMO and claimed that they feel uneasy or nervous if they don't have access to social media networks for a longer period of time.

To sum up, FOMO is a complex construct that describes the feeling of anxiety that others have more rewarding experiences. It is a highly social phenomenon, linked to the need to belong, and the need of inclusion. Even though FOMO is mostly studied in link with online activities, researchers claim that people experience FOMO independently of how they found out about the alternative activities whereas digital devices, Internet and social media simply increase the likelihood for people to find out about it. Even though some personality traits are considered likely linked to experiencing FOMO, this phenomenon is claimed to be a combination of dispositional characteristics and situational response. There is a suggested bidirectionality between FOMO and problematic Internet or smartphone use. FOMO is a so-called "informative metric" (Baker et al. 2016:280) about one's relationship with technology and social media, as its effects are linked to such negative outcomes as social media addiction, problematic smartphone use and increase of stress during social media use.

However, due to FOMO's influence in development of negative consequences of maladaptive technology use, the negative effects go beyond social media use alone, impacting one's physical, emotional, and cognitive health and the quality of everyday life. It is suggested that adolescents, women, and individuals with some anxiety predispositions are more inclined to experience FOMO. Because FOMO is becoming a known concept in everyday life, some ways to abuse the phenomenon emerge both in peer to peer and commercial contexts.

1.1.2 Wearable Technology

This section provides an outline about the current development as well as an outlook on wearable technology and a conceptualization of wearable devices. The first question that is going to be addressed is what is understood under wearables, and what category of technology wearables fall into.

The field of Information and Communications Technology (ICT) is characterized by an immense growth both in terms of new services and user demands. This constant development filled the market with a variety of interconnected devices creating the phenomenon called the Internet of Things (IoT).

Internet of Things (IoT) is an umbrella term for a new paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications. As it is the case with some concepts in ICT, there is little to no unity in the definition of IoT. These differences are explained by the fact that stakeholders, business alliances, research and standardization bodies approach the issue from either an "Internet oriented" or a "Things oriented" perspective, depending on the context as well as their specific interests and backgrounds (Atzori, Iera, and Morabito 2010:2788). Additionally, authors suggest a third, "Semantic oriented" vision (Atzori et al. 2010:2788–90), where the IoT consists of two words and concepts: "Internet" and "Thing", and means "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols" (INFSO D.4 NETWORKED ENTERPRISE & RFID INFSO G.2 MICRO & NANOSYSTEMS in co-operation with the WORKING GROUP RFID OF THE ETP EPOSS 2008:4). Another definition that draws focus on the functionality and identity of the notion is: "Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts" (INFSO D.4

NETWORKED ENTERPRISE & RFID INFSO G.2 MICRO & NANOSYSTEMS in co-operation with the WORKING GROUP RFID OF THE ETP EPOSS 2008:4).

The "object"-oriented perspective focuses on technological enablers of the IoT, on solutions that enable smart wireless devices, mostly wireless sensors, to establish temporary relationships, for instance, Radio-Frequency Identification (RFID) (Atzori et al. 2012:3595, 2010:2788).

The idea behind the network-oriented vision of the paradigm shift is that the current Internet is the collection of rather "uniform" devices, even though heterogeneous in form and capabilities but very similar in purpose and function. However, with the current developments, IoT enables a much higher level of heterogeneity in terms of functionality, technology and application fields (INFSO D.4 NETWORKED ENTERPRISE & RFID INFSO G.2 MICRO & NANOSYSTEMS in co-operation with the WORKING GROUP RFID OF THE ETP EPOSS 2008:4). These diverse objects are connected in the same communication environment and operate in a networked manner, supposedly autonomously.

To reiterate, IoT is distinct through the shift from mostly being an enabler of human powered communication to a more diverse one. While "Internet is mostly used for the publishing and retrieving of information (…) and therefore, information should be the focus of communication and networking solutions" (Atzori et al. 2010:2803), in IoT the communication is no longer straightforward either human-to-human or human-to-machine. IoT broadens the spectrum among others by adding machine-to-machine networking beside machine-to-human reporting. Consequently, the term "Social Internet of Things" (SIoT) was created, due to the convergence of "the "Internet of Things" and the "Social Networks" worlds (Atzori et al. 2012:3594). The idea behind SIoT is that objects within the IoT will profit from building social relationships with each other. What is important about these relationships that can have different patterns of interactions, is that they would occur without human intervention. For example, a laptop can turn to other devices within the network to problem solve some connection issues, a car can plan a better route by gathering information by contacting some "friend" devices in the desired geographical location (Atzori et al. 2012:3602).

The IoT's applicability spreads from assisted living and intelligent home solutions to transportation as well as industrial solutions such as retail and logistic improvements. Even

though the development of the IoT is unlikely to disrupt the current industry fundamentally, this change in the communication environment is supposed to improve efficiency and enable some value-adding features (INFSO D.4 NETWORKED ENTERPRISE & RFID INFSO G.2 MICRO & NANOSYSTEMS in co-operation with the WORKING GROUP RFID OF THE ETP EPOSS 2008:11).

It is valuable to distinguish the overarching characteristics of the IoT objects to analyze these aspects when coming to a higher level of de-generalization later. The focus of this paper, Internet of Wearable Things (IoWT), has emerged as part of a broader IoT and will be presented below.

Wearable devices, also called wearables or wearable technology, is a term referring to "small electronic and mobile devices, or computers with wireless communications capability that are incorporated into gadgets, accessories, or clothes, which can be worn on the human body, or even invasive versions such as micro-chips or smart tattoos" (Ometov et al. 2021:1). Wearables differ in a variety of technical and applicational aspects but also in their "degree of smartness" (Atzori et al. 2010:2788): the level of their adaptation and the enabled autonomous behavior.

There are several ways to group or classify the variety of wearable devices. Depending on the perspective, scholars categorize wearables based on functionality or application type, on the device type, based on their energy-consumption profile, on the type of battery they use, or on the placement of the wearable on the human body (Ometov et al. 2021:6–8). The latter is considered to be the most intuitive classification factor from the consumer perspective. Here, the four main groups are, depending on where the device is to be located:

- Head-mounted wearables,
- Body-worn devices, that can be further divided into 1. Near-body and Sport; 2. On-body; 3. In-body wearables,
- Lower-body devices as well as
- Wrist-worn and handheld wearables (Ometov et al. 2021:6–7).

Wrist-worn wearables such as smart rings, sport bands and smartwatches are therefore a separate group and described as the most widely adopted and "market-filled niche" (Ometov et al. 2021:7).

While modern wearable technology faces a list of challenges in various aspects from data processing and privacy issues to architectural and hardware specific problems such as lack

of modern energy harvesting opportunities and device longevity (Ometov et al. 2021:24), it is still developing with tremendous speed and success in various industries. Since 2011, when the first three brands had pioneered the market there is a clear growth of the offer of wearable devices and brands on the market. New devices and brands are released every year, promising improved measurements and user experience. Worldwide wearables sales are prognosed to keep rising significantly, reaching 632 million units in 2024 (IDC 2020). At the same time, other brands disappear from the consumer market for various reasons.

As mentioned above, this development in the field of wearable technology causes a paradigm shift as "network operators and vendors" start "to redesign the entire ecosystem, switching from conventional human-generated traffics to more diverse IoT one" (Ometov et al. 2021:1).

For consumers the main value added of most wearables is constant biodata collection and processing. Users turn to wearables because they value self-tracking of moods and feelings, physical activities, diet regulations, sleep patterns and consumption habits (Koo and Fallon 2018:12).

Even though the market of wearables is rich in new devices and brands, only a few well-established brands are frequently used in research projects (Henriksen et al. 2018:1,12). Out of 132 brands available in 2017, the five most often used in research projects were Fitbit, Garmin, Misfit, Apple, and Polar, with Fitbit being far ahead (Henriksen et al. 2018:1).

In Austria in 2020 Garmin was leading with 20% of surveyed responding they have a wearable from the company. This can be explained among others by the number of single devices a company has, which was a record 40 devices in 2017 for Garmin (Henriksen et al. 2018:4). Apple and Samsung were sharing a second spot in 2020 in Austria with 17% each. Fitbit that was a leader in 2017 in research projects was in the third place in consumer preferences with 10% of users.

When conceptualizing wearable computing in 2001, ten years before the first smartwatches entered the market, the following desirable characteristics were attributed. Firstly, wearable computer must persist and provide constant access to information services. The device is supposed to be designed for everyday continuous use and be able to "interact with the user at any given time, interrupting when necessary and appropriate" (Starner 2001a:46). Secondly, the wearable is supposed to sense and model context and as a result adapt

interaction modalities based on the user's context. Finally, the wearable should augment and mediate interactions with the user's environment (Starner 2001a:46). These features imply constant availability of the device, as well as data collection and processing, machine learning and algorithmic suggestions. The author also mentions modeling of "the user's environment, the user's physical and mental state, and its own internal state" (Starner 2001a:46) which references features smartwatches are pursuing with health and fitness tracking, as well as uses they are finding in research studies (Quiroz et al. 2018:2).

Even though smartwatches are prognosed to be the second most popular wearable after earwear, or hearables, around 156 million smartwatches are prognosed to be sold in 2024 worldwide (Statista 2021:8). Apple is a clear worldwide market leader of smartwatch manufacturers with around 28 percent market share in the second quarter of 2021 (Statista 2021:12). Huawei and Samsung are in the second and third place with 9.3% and 7.6% correspondingly. Imoo and Garmin are in the end of the leading manufacturers list with 6% and 5.8% market share (Statista 2021:12).

1.1.2.1 Definitions Smartwatch vs. Fitness-tracker

This section provides an overview of the discussion on differences between types of wrist-worn devices, derives the criteria relevant to the framework of this research and summarizes the conceptualization of smartwatches in the literature.

Smartwatches are a category of consumer sport and fitness wearables (CSFWs) (Ash et al. 2021:2238). The field of CSFWs possesses remarkably high levels of "heterogeneity, multi-tiered development, dynamicity, and nebulousness" (Ash et al. 2021:2237). On the one hand, devices differ in technical contexts such as "data types, and contexts for data collection" (Ash et al. 2021:2237), on the other hand, wearable devices lack a clear definition and classification. Wrist-worn wearables have several subtypes that are not always easy to distinguish from each other. These subtypes include among other fitness-bands, fitness-trackers, smartwatches, and hybrid smartwatches. Hence the interest of this paper is in smartwatches, several definitions and distinguishing points of smartwatches are going to be considered.

In literature smartwatch is defined as "a wrist-worn device with computational power, that can connect to other devices via short range wireless connectivity; provides alert notifications; collects personal data through a range of sensors and stores them; and has an

integrated clock" (Cecchinato, Cox, and Bird 2015:2). The first aspect of short-range connectivity is represented in another definition where authors focus on the value smartwatches bring to users. They define smartwatch as "a wrist-worn device that, mostly, acts as an extension to a mobile phone and can show notifications and track PA [physical activity] and related metrics" (Henriksen et al. 2018:3). Altogether, smartwatches are seen as "mini computers" (Chuah et al. 2016:276), even though they mostly work in connection with other devices and smartphones in particular, smartwatches possess computational power and complex technical equipment that allows them to perform actions described above.

However, the difference between modern fitness trackers and smartwatches is not that unambiguous, as some fitness trackers have an integrated smart notification feature that allows connection to SMS, as well as weather and music applications. Therefore, such fitness trackers technically satisfy the definitions above. Some definitions are limited to basic requirements such as being "equipped with a screen and sensors" (Siepmann and Kowalczuk 2021:795). Another frequently mentioned aspect includes the ability to run proprietary as well as third-party apps (Nascimento et al. 2018:157). Smartwatches could also be categorized as a "smaller version of existing devices, such as smartphones or organizers" (Chuah et al. 2016:277).

For the purpose of this research neither technical details nor narrower conceptual definitions are of essence, therefore the broader definition that are based on features and benefits users gain from smartwatch usage is going to be adopted. The most important features within this research that distinguish smartwatches from other digital and wearable devices include being a wrist-worn wearable with the ability to run communication and self-tracking applications that are enabled by sensors and provide push notifications about them.

The topic of smartwatch acceptance and popularity is disputed similarly to the definitions. While some describe the market as rapidly expanding (Ash et al. 2021:2238), others note that the market growth remained below the expectations and forecasts despite large investments in smartwatch development (Visuri et al. 2021:535). In the years 2015-2016 several forecasts overpredicted (Cecchinato et al. 2015:2) the success of wearable technology that did not live up to the "hype" (Ha et al. 2017:1263). However, the smartwatch market continued its growth becoming an emerging area of academic research (Wu, Wu, and Chang 2016:383). By 2020, 25.7% of surveyed internet users indicated that they owned a

smartwatch (Statista 2020b:13). Smartwatches experienced immense growth during 2021, superseding traditional watches (Deloitte Deutschland and INHORGENTA MUNICH 2021:12–15). The global demand for smartwatches is growing exponentially, despite the impact of COVID-19 (Deloitte Deutschland and INHORGENTA MUNICH 2021:12–15).

By now, smartwatches are well accepted by users with around 50% of users being satisfied (Bundesverband Digitale Wirtschaft (BVDW) e.V., DAYONE GmbH, and defacto digital research GmbH 2016:7). They are more accepted by young people who want to have their results displayed and demonstrated, and see smartwatches as a chance to show off the novel characteristics of the device and a fashion accessory offering either a chic look or novel functionalities to friends (Wu et al. 2016:389). Besides that, younger consumers increasingly purchase digital wristwear to track their fitness and health (Deloitte Deutschland and INHORGENTA MUNICH 2021:12–15). However, there still is some confusion among users as to what the real benefit of a smartwatch is, because of not clearly defined additional functionality next to conflicting expectations concerning smartwatches' aesthetics (Cecchinato et al. 2015:6). Researchers think that the "killer app" that would create special use cases for the smartwatch was not offered yet (Min et al. 2015:12).

Next, smartwatch uses are going to be discussed. There are several perspectives to study this question in the literature. Some research focuses on regular user perspective and some on academic or commercial usages.

From a regular user or consumer perspective, smartwatches fall simultaneously into two categories of goods: fashion and technology (Chuah et al. 2016:281–82). Therefore, smartwatches need to promise both usefulness in technological terms and visibility as a fashion statement. "Wearable computing represents an unusual intersection of science, engineering, design, and fashion" and has a social aspect (Starner 2001b:60). Smartwatches are used for notifications, as a traditional watch, as a health or fitness tracker, as an entertainment device and as a combination of the above (Cecchinato et al. 2015:4).

Smartwatches are designed for continued consistent use, and habit plays an important role in affecting a user's intention to continue using a smartwatch (Nascimento et al. 2018:165). Another key factor is claimed to be satisfaction that consists of the confirmation of the selling promise, perceived usefulness, perceived usability, and perceived enjoyment (Nascimento et al. 2018:165).

Notably, smartwatch user patterns change over time and one pattern based on the diffusion of innovation theory is the existence of a "learning" or "adaptation" phase (Visuri et al. 2021:542). When transitioning from the "exploratory" behaviors characterizing this phase, users move to more passive behaviors that tend to be affiliated with less active use, showcasing fewer daily usage sessions, less notifications and shorter longitudinal usage streaks and phases (Visuri et al. 2021:454). A study has found that users' needs were also different depending on the period they had been using their smartwatch. While they grew accustomed to checking notifications via the smartwatch and use activity tracking, the watch functionality (e.g., checking time, and using stop watch and alarm) became less important (Min et al. 2015:12–13). Additionally, experienced users seem to have more concerns about privacy and many preferred not sharing their tracked data with others (Koo and Fallon 2018:9).

From an academic perspective, smartwatches provide a variety of uses enabled by gyroscopes and accelerometers that can sense a user's movements and machine learning that can identify the activity a user is performing. For example, smartwatches are employed for emotion recognition based on the movement sensor data (Quiroz et al. 2018:18). Due to machine learning applied to the data collected by movement sensors, smartwatches can be utilized in a variety of biomedical and health applications, including applications that automatically track biodata such as eating habits (Weiss et al. 2016:426). Additionally, sensors were proven to detect heart conditions (Bumgarner et al. 2018:2381) and prevent the risk of stroke in patients with preconditions (Turakhia et al. 2019:66).

To sum up, smartwatches are a category of wrist-worn wearable devices that contribute to paradigm shift within the IoT. Smartwatches entered the market relatively late and did not live up to the "hype" that overpredicted their popularity. Despite that, the smartwatch market continued its growth, delivering value added to the customers in both commercial and academic fields. For the purposes of this research, a relatively wide definition was adopted based on the features and benefits users gain from smartwatch usage that include device connectivity, sensor enabled fitness tracking and alert notifications from proprietary as well as third-party apps.

1.2 Deriving the Research Questions

As indicated above, the main goal of this study is to investigate the interrelation between the wearable technology on the example of smartwatches and the fear of missing out. Therefore, the first research question was defined as follows.

RQ1: What is the relationship between smartwatch usage and FOMO?

The second area this research focuses on is the attempt to study in detail the specific behavior smartwatch users have in reaction to notifications on their wrist wearable devices. The interest lies in analyzing how people react to alert notifications on a smartwatch and if there is a great boost to check and respond immediately because it is on their wrist, in comparison to other digital devices that are not always physically as close. To explore this in detail, the following research question was derived.

RQ2: What is smartwatch-users' specific response pattern behavior in relation to FOMO of notifications?

Thirdly, looking into other specific features and services wearables enable, the research analyzes the niche of self-tracking applications and behaviors according to the third research questions.

RQ3: How does self-tracking effect FOMO?

1.3 Objective and Method of Work

The objective of this paper is to study the relationship between smartwatches as an example of wearable devices and the fear of missing out.

In order to investigate the smartwatch-users' specific behavior in relation to FOMO, it must be identified whether the concept developed primarily in relation to social media usage on smartphones can be applied to smartwatch usage. To accomplish this, the components of usage that are unique to smartwatches are going to be analyzed. One key feature of these devices that is going to be put in perspective in the following section is self-tracking. While FOMO is a sociopsychological phenomenon with the social relation at core, it is of interest of this paper to investigate whether FOMO that is applicable on SMS can be employed for self-tracking.

To reiterate, the first problem this paper focuses on is the question whether the concept of FOMO is suitable for wearable devices, whether the social aspect is not the only core

functionality. Social interaction may be not the primary aspect of wearables, however, the technology itself can be viewed as a feedback-device and promote certain habitual and behavioral pattern or pattern change.

In terms of research methods, a mix-method approach was considered to evaluate the user experience. However, because quantitative research in form of an online questionnaire compromised quality of the research in terms of the effect of social desirability, in sake of preserving the validity of this research, the methods will be limited to qualitative interviews. To preserve the validity of this research, methods will be limited to qualitative interviews excluding quantitative ones, namely online questionnaire, as they appeared to compromise quality of the research by having an effect of social desirability. The research concerns the sociopsychological phenomenon of FOMO, a sensitive and a rather negative topic that involves high levels of self-reflection, and therefore self-assessment tools such as online questionnaires would not provide valid measurement at risk of becoming self-fulfilling prophecies.

To generate the hypotheses, qualitative interviews with following data analysis and interpretation will be executed (Jensen 2021:298). Because the topic of the analysis is rooted in participants' experience with the wearable technology, the effect of social desirability is less likely to occur and will be a part of natural setting and following interpretation (Jensen 2021:287).

1.4 Structure of the Thesis

The first chapter provided the first look into the problem, reasoned the value of the research and the contributions it will provide. Next, the definitions and partially current state of research on the topic of FOMO was summarized, including the findings made hitherto. Hence, FOMO is a complex construct that manifests itself on different levels of media use, several viewpoints on the topic were developed in the previous research. The section provided an overview on what implications and links FOMO has, in what contexts it is studied, what demographic group is considered especially vulnerable towards it and finally, what research has been made on managing or fighting FOMO. Afterwards the second part of the research interest – the wearable technology – was introduced. From higher level and gradually de-generalizing, the concepts of IoT and IoWT were presented. The implications this paradigm shift has for the communication technology was briefly discussed. General classifications of wearables and current state of the market were discussed. Further, the

definitions of smartwatches and fitness-trackers were compared and a definition relevant for this paper was decided upon. Next, based on the introduction of the research interest, research questions were derived. Finally, a short objective and description of the method of work was appointed.

In the second chapter, theoretical implications are discussed with the goal of creating a research-specific conceptual model. The model is based on the theories applied to study the subject in the literature. For this purpose, a literature review is conducted to conceptualize FOMO and simultaneously discuss whether the concept can be applied to smartwatches. Three theoretical entities most frequently used in relation to FOMO are identified and addressed in-depth: Self-Determination Theory, Person-Affect-Cognition-Execution (I-PACE) model and Compensatory Internet Use Theory (CIUT). Afterwards it is discussed how FOMO is studied and measured. Four main approaches to study FOMO are identified and summarized: FOMO in connection to smartphone, to social media, to the Internet and FOMO as an independent psychological phenomenon. Further, the FOMO scales used in previous research were addressed with a question whether they can be applied to measure FOMO in the context of smartwatches. Next, the question of additional factors to consider while applying the FOMO concept to smartwatches is analyzed. For that a short overview of smartwatch research in terms of distinguishing features is presented. After identifying the areas that are smartwatch-specific, their impact on the research topic is critically questioned. Finally, based on the previous considerations a conceptual model is created.

In the third chapter, the model is applied to operationalize the research questions, derived above and to investigate it in a qualitative user study. The empirical research consists of qualitative user interviews conducted partially in person and partially online. After determining the sample and discussing the appropriate research method, data is collected, recorded, and transcribed. Content-structuring content analysis is conducted with help of MAXQDA software. Every important step of the analysis and interpretation are documented. Findings are discussed and put into perspective based on the conceptual model and literature.

Finally, the findings from both theoretical and empirical parts are summarized with the goal of providing conclusions. Recommendations for action are provided. The paper ends with a discussion of the study's limitations and implications.

2 Theoretical Part

In this section, the focus lies on the first research question in an effort to investigate the interrelation between wearable technology and fear of missing out. For this purpose, an extensive literature review is conducted to investigate if the FOMO concept is applicable to wearable devices and specifically smartwatches. This section will be structured as follows: firstly, a summary of research on FOMO is going to be created. The aim of this part is to identify, on the one hand, what theoretical framework or method is used to study FOMO concept, and to find out what constitutes FOMO in literature, on the other hand. Secondly, the theoretical framework used to study smartwatches is going to be characterized and the summary of unique features that characterize smartwatches will be drawn with the goal of establishing the main differences between smartwatches and devices whose link to FOMO was studied before. Finally, an analysis is going to be conducted to deduce whether it is possible to apply the FOMO concept to smartwatches and smartwatch users, and what needs to be accounted for.

2.1 Conceptualizing FOMO

The method of conducting this review was employed as follows. Search engines of the university of applied sciences in St. Pölten and Södertörn university in Stockholm, as well as such resources as Google Scholar, Research Gate and Sage Journal Online were utilized in the initial inquiry. The papers for the review were sorted out according to the relevance to the question of this paper, focusing either on the concept of FOMO itself or its implications as a sociopsychological phenomenon in the context of media or adjacent studies, such as computer science or (media-) psychology. The results are shown in the Table 1.

Based on both the research question of this paper and the considerations above, the following aspects of each paper in literature review were identified as the most important: the theoretical entity used to study the subject, general research topic and key variables or in specific cases results of the research. Paper's research topic is used as an indicator of paper's relevance within this research, the theoretical framework provides an overview of the theoretical lenses FOMO is studied within. Key variables are identified to summarize the conceptualization of FOMO. Some papers focus on some specific aspects of the FOMO concept, for instance, on the development of a scale to measure individual FOMO and its factors. In such case the results were reported instead of variables that became secondary.

Table 1. FOMO Literature review

Author(s)	*Title*	*Research topic*	*Key variables/results*	*Theory/Model*
(Adams et al. 2017)	The young and the restless: Socializing trumps sleep, fear of missing out, and technological distractions in first-year college students	To explore factors that impacted sleep during the first semester of college	Three themes that impacted students' sleep: socializing trumps sleep; fear of missing out; and social/ technological distractions	The biopsychosocial model
(Alt 2015)	College students' academic motivation, media engagement and fear of missing out	To examine possible links between FOMO, social media engagement, and three motivational constructs: Intrinsic, extrinsic and amotivation for learning	Social Media Engagement (SME), Fear of Missing Out and Academic Motivation	Self-determination theory (SDT)
(Alt 2017)	Students' social media engagement and fear of missing out (FoMO) in a diverse classroom	To measure the relative impact of FOMO on students' social media engagement SME for personal reasons during lectures	Social media engagement (SME)	
(Alt 2018)	Students' Wellbeing, Fear of Missing out, and Social Media Engagement for Leisure in Higher Education Learning Environments	Aimed at assessing the assumption that maladjustment to college could lead some toward excessive social media engagement for leisure during class	Social media engagement (SME)	
(Alt and Boniel-Nissim 2018)	Links between Adolescents' Deep and Surface Learning Approaches, T Problematic Internet Use, and Fear of Missing Out (FOMO)	To explore the links between adolescents' deep and surface approaches to learning, Fear of Missing Out (FOMO), and Problematic Internet Use (PIU)	Learning approaches, FOMO and Problematic Internet Use (PIU)	The theory of learning approaches
(Baker et al. 2016)	Fear of Missing Out: Relationships with Depression, Mindfulness, and Physical Symptoms	To test the associations between social media use, FOMO, and a range of mental and physical health outcomes	FOMO, social media use, depressive symptoms, mindful attention, and physical symptoms	Self-determination theory (SDT)
(Balta et al. 2020)	Neuroticism, Trait Fear of Missing Out, and Phubbing: The Mediating Role of State Fear of Missing Out and Problematic Instagram Use	To investigate the direct and indirect associations of neuroticism, trait anxiety, and trait fear of missing out with phubbing via state fear of missing out and problematic Instagram use	Different dimensions of fear of missing out, problematic Instagram use, and phubbing	
(Beyens et al. 2016)	"I don't want to miss a thing": Adolescents' fear of missing out and its relationship to adolescents' social needs, Facebook use, and Facebook related stress	To examine the relationships of adolescents' social needs with adolescents' Facebook use as well as relationships of adolescents' fear of missing out with adolescents' Facebook related stress	Need to belong, need for popularity, Fear of missing out, Facebook use, perceived stress related to Facebook use	Self-determination theory (SDT)

(Blackwell et al. 2017)	Extraversion, neuroticism, attachment style and fear of missing out as predictors of social media use and addiction		Extraversion, neuroticism, attachment styles, FOMO, social media use and addiction	Self-determination theory (SDT)/ Attachment theory
(Buglass et al. 2017)	Motivators of online vulnerability: The impact of social network site use and FOMO	To test associations between SNS use and online vulnerability	Vulnerability, self-promoting, self-esteem, social network sites (SNS)	
(Holte and Ferraro 2020)	Anxious, bored, and (maybe) missing out: Evaluation of anxiety attachment, boredom proneness, and fear of missing out (FOMO)	To test mediating factors between anxiety and depression severity and FOMO	Anxiety attachment, boredom proneness, SNS, FOMO	Self-determination theory (SDT)/ Attachment theory
(Can and Satici 2019)	Adaptation of fear of missing out scale (FOMOs): Turkish version validity and reliability study	To examine the construct validity of the Turkish version of the FOMO scale	Has proven the adapted version of the fear of missing out scale into Turkish context to be a valid and reliable instrument	Self-determination theory (SDT)
(Casale and Fioravanti 2020)	Factor structure and psychometric properties of the Italian version of the T fear of missing out scale in emerging adults and adolescents	To test FOMO scale in an Italian context	The Italian version of the Fear of Missing Out Scale (FoMOs) demonstrates good psychometric properties, two-factor solution of the FOMOs	Self-determination theory (SDT)
(Casale and Fioravanti 2020)	Exploring the role of positive metacognitions in explaining the association between the fear of missing out and social media addiction	To analyze the role of positive metacognitions on mediating the association between FOMO and problematic SNSs use	FOMO, fear of negative evaluation and self-presentational skills, positive metacognitions, problematic SNSs use	
(Chotpitayasunondh and Douglas 2016)	How “phubbing” becomes the norm: The antecedents and consequences of snubbing via smartphone	To examine some of the psychological antecedents and consequences of phubbing behavior, including the contributing roles of Internet addiction, fear of missing out, self-control, and smartphone addiction	Internet addiction, fear of missing out, self-control, and smartphone addiction	
(Dempsey et al. 2019)	Fear of missing out (FOMO) and rumination mediate relations between social anxiety and problematic Facebook use	To examine a structural equation model whereby depression, social anxiety and lower life satisfaction predicted PFU severity, while analyzing mediating variables including rumination, fear of missing out (FoMO), and frequency of Facebook use, as well as age and gender as covariates.	Problematic social networking site use, Fear of missing out, rumination, social anxiety	Compensatory Internet Use Theory (CIUT), Person-Affect-Cognition-Execution (I-PACE) model, Differential Susceptibility to Media Effects Model (DSMM)

(Dhir et al. 2018)	Online social media fatigue and psychological wellbeing—A study of compulsive use, fear of missing out, fatigue, anxiety and depression	To examine whether psychosocial wellbeing measures, such as compulsive media use and fear of missing out, trigger fatigue and, furthermore, whether social media fatigue results in anxiety and depression	Social media fatigue, compulsive media use, FOMO, anxiety, and depression	Stressor-strain-outcome (SSO) model
(Elhai et al. 2016)	Fear of missing out, need for touch, anxiety and depression are related to problematic smartphone use	To examine variables conceptually related to problematic smartphone use and use frequency	Problematic smartphone use, frequency of smartphone use, depression and anxiety and possible mechanisms including behavioral activation, need for touch, fear of missing out (FOMO), and emotion regulation	Problematic mobile phone use model
(Elhai et al. 2018)	Fear of missing out: Testing relationships with negative affectivity, online T social engagement, and problematic smartphone use	To examine the "fear of missing out" (FOMO) construct and its association with psychopathology-related and technology use measures	FOMO, frequency and type of smartphone use, problematic smartphone use (PSU), negative affectivity including depression, anxiety, stress, proneness to boredom, and rumination	Self-Determination Theory (SDT), Compensatory Internet Use Theory (CIUT)
(Elhai et al. 2020)	Fear of missing out predicts repeated measurements of greater negative affect using experience sampling methodology	To examine relations between FOMO and repeated measurements of negative affect over one week	FOMO, depression, anxiety severity and negative affect	Self-determination theory (SDT)
(Franchina et al. 2018)	Fear of Missing Out as a Predictor of Problematic Social Media Use and Phubbing Behavior among Flemish Adolescents	To explore the relationships between FOMO, social media use, problematic social media use (PSMU) and phubbing behavior among Flemish teenagers	Problematic social media use (PSMU), phubbing, FOMO	Self-determination theory (SDT), Uses & Gratifications Theory (UGT)
(Hetz et al. 2015)	Social Media Use and the Fear of Missing Out (FoMO) While Studying Abroad	To determine how social media affects the study abroad experience, and in particular, whether students studying abroad experience FoMO	Social media use	
(Lai et al. 2016)	Fear of missing out (FOMO) is associated with activation of the right middle temporal gyrus during inclusion social cue	To investigate the neurobiological correlates of fear of missing out in response to the social exclusion and social inclusion cue	Social inclusive experiences, social exclusion, need of belong and FOMO	
(Lo Coco et al. 2020)	Examining bidirectionality between Fear of Missing Out and problematic T smartphone use. A two-wave panel study among adolescents	To examine the direction of the association between FOMO and problematic smartphone use (PSU) among adolescents in a longitudinal design	FOMO and problematic smartphone use (PSU)	Self-determination theory (SDT)

(Milyavskaya et al. 2018)	Fear of missing out: prevalence, dynamics, and consequences of experiencing FOMO	To research whether FOMO experiences were uniquely linked to social media usage, and whether FOMO could be distinguished from more general self-regulation conflicts in which one must delay gratification and persist at a boring task	Well-being, self-regulation, links between FOMO and social media	Rational choice theory, Uses & Gratifications Theory (UGT)
(Oberst et al. 2017)	Negative consequences from heavy social networking in adolescents: The mediating role of fear of missing out	To analyze the role of fear of missing out (FOMO) and intensity of SNS use for explaining the link between psychopathological symptoms and negative consequences of SNS use via mobile devices	Negative consequences of mobile device use, social network sites (SNS), social networking intensity	
(Przybylski et al. 2013)	Motivational, emotional, and behavioral correlates of fear of missing out	The first study to create a scale to measure individual differences in FOMO and examine the behavioral and emotional correlates of FOMO in a sample of young adults	Development of FOMO scale	Self-determination theory (SDT)
(Rozgonjuk et al. 2020)	Fear of Missing Out (FoMO) and social media's impact on daily-life and productivity at work: Do WhatsApp, Facebook, Instagram, and Snapchat Use Disorders mediate that association?	To investigate the association between FoMO and social media use's impact on daily-life and productivity at work	Social networks use disorder (SNUD) and FOMO	Person-Affect-Cognition-Execution model (I-PACE)
(Tomczyk and Selmanagic-Lizde 2018)	Fear of Missing Out (FOMO) among youth in Bosnia and Herzegovina — Scale and selected mechanisms	To diagnose FOMO in a large population in Bosnia and Herzegovina	Internet addiction, problematic Internet use, IAT	Internet Addiction Test (IAT)
(Wegmann et al. 2017)	Online-specific fear of missing out and Internet-use expectancies contribute to symptoms of Internet-communication disorder	To investigate the role of psychopathological symptoms and the fear of missing out on expectancies towards Internet-communication applications in the development of symptoms of an Internet-communication disorder	Internet addiction, social networking sites (SNS), Internet-communication disorder (ICD)	Interaction of Person-Affect-Cognition-Execution (I-PACE) model
(Wolniewicz et al. 2018)	Problematic smartphone use and relations with negative affect, fear of missing out, and fear of negative and positive evaluation	To survey the problematic smartphone use, social and non-social smartphone use, and psychopathology-related constructs including negative affect, fear of negative and positive evaluation, and fear of missing out (FOMO).	Social anxiety, depression, smartphone addiction, Internet addiction	Uses and Gratifications Theory (UGT), Compensatory Internet Use Theory (CIUT)

The following conclusions can be drawn based on an extensive literature review, illustrated in Table 1. In the literature FOMO is predominantly studied within the Self-Determination Theory (SDT). The Person-Affect-Cognition-Execution (I-PACE) model is also widely applied. Some scholars employ Attachment theory; Compensatory Internet Use Theory (CIUT), Uses and Gratifications Theory (UGT), the Theory of Learning Approaches, and Rational Choice Theory are among others frequently applied. Applied models include Differential Susceptibility to Media Effects Model (DSMM), the Biopsychosocial model, Stressor-strain-outcome (SSO) model and Problematic mobile phone use model.

For the sake of this analysis, one of the most frequently used models and two theories as well as their implications are going to be discussed.

Self-Determination Theory (SDT) is a macro theory of human motivation that claims that effective self-regulation and psychological health are based on the satisfaction of three basic psychological needs: competence – the capacity to effectively act on the world, autonomy – self-authorship or personal initiative, and relatedness – closeness or connectedness with others.

SDT consists of five mini theories. The first one is the Cognitive Evaluation Theory that constitutes the factors that either undermine or support intrinsic motivation. Even though external events do not happen in vacuum and therefore the effects may vary, such controlling external events as threat of punishment, deadlines, evaluation, competition, and surveillance are considered to undermine intrinsic motivation. Moreover, it is claimed that rewards undermine intrinsic motivation, although this effect was not evident for unexpected rewards and was less potent for performance-contingent (rather than engagement- or completion-contingent) rewards (Vansteenkiste, Niemiec, and Soenens 2010:108). Positive feedback and choice, on the other hand, are mostly found to facilitate intrinsic motivation (Vansteenkiste et al. 2010:109–10).

The second mini theory is Organismic Integration Theory that goes deeply into exploration of external motivation and its facets. The idea behind this theory is that extrinsic motivation can be experienced as autonomous to the extent that people feel a sense of ownership over their behavior and have fully endorsed the personal value and significance of the behavior. To achieve that one foregoes a so-called internalization continuum, moving from fully external regulation where they are forced to follow the rules, through introjected regulation

– motivated by the desire to avoid feeling guilt and shame, and identified regulation – in which one understands the value and significance of a behavior, and finally to integrated regulation – where one fully integrates and adopts the values as a part of the self (Vansteenkiste et al. 2010:114–17).

The third mini theory, Causality Orientations Theory focuses on individual differences in motivational orientations. Within this theory the relation of the autonomy and control orientations to openness and defensiveness are examined (Vansteenkiste et al. 2010:127). The fourth mini theory is the Basic Needs Theory. Within it, autonomy (refers to the experience of volition and psychological freedom), competence (refers to the experience of certainty in one's pursuits) and relatedness (refers to the experience of reciprocal care and concern for important others) are considered to be necessary for psychological and physical health, and social wellness (Vansteenkiste et al. 2010:131). The last mini theory constituting SDT is Goal Content Theory. Similarly to the differentiation between intrinsic and extrinsic motivation, intrinsic and extrinsic categories of life goals, or aspirations, that people pursue, are distinguished (Vansteenkiste et al. 2010:145).

Based on the assumption that basic need satisfaction is associated with proactive behavioral regulation, authors of the original conceptualization of FOMO suggested that the FOMO phenomenon „can be understood as self-regulatory limbo arising from situational or chronic deficits in psychological need satisfactions" (Przybylski et al. 2013:1842).

The Person-Affect-Cognition-Execution (I-PACE) model provides a theoretical framework for clinical research and practice that distinguishes between predisposing factors and moderating and mediating variables for specific Internet-use disorders (Brand et al. 2016:261). It illustrates the following components: predisposing variables, affective and cognitive responses to internal or external stimuli, executive and inhibitory control, decision-making behavior resulting in the use of certain Internet applications/sites, and consequences of using the Internet applications/sites of choice (Brand et al. 2016:254). Predisposing variables include a person's biopsychological constitution, such as "genetic factors and other biological determinants of human behavior, such as ontogenetic aspects and early childhood experiences and their resulting biological consequences and effects on learning experiences" (Brand et al. 2016:254). Affective and cognitive responses emerge in a subjectively precepted situation and may be risk or resilience factors for internet use. They consist of coping strategies, cognitive biases, urge for mood regulation and craving, as well as

attentional biases (Brand et al. 2016:256–58). Such responses may lead to the decision to use a particular type of internet use or application that lead to gratification which in turn may lead to developing Internet disorder as a result of conditioning processes (Brand et al. 2016:259).

In FOMO research the I-PACE model is applied, for example, to hypothesize that the tendency to experience FOMO could be viewed as a predisposing factor in terms of developing an Internet-use disorder (Rozgonjuk et al. 2020:2).

Compensatory Internet Use Theory (CIUT) states that "negative life situations can give rise to a motivation to go online to alleviate negative feelings" (Kardefelt-Winther 2014:352). This theory is claimed to expand previously limited approaches to study Internet addiction by adding such elements as the affordances of the online activity and motivations for going online. While previously the approach consisted only of psychosocial vulnerabilities and problematic outcomes of internet use, with the help of CIUT researchers could describe the observed situation in greater detail by providing a situational explanation and reasons behind the excessive use (Kardefelt-Winther 2014:353).

In FOMO research, CIUT is applied to study the relations of FOMO to problematic Internet use as FOMO can be seen as a means to fulfill and compensate for individuals' social needs (Wolniewicz et al. 2018:619).

Within this research the question whether the FOMO concept could be applied to smartwatches in the framing of these theories is of relevance.

In a broader sense, FOMO is described as "fears, worries, and anxieties people may have in relation to being in (or out of) touch with the events, experiences, and conversations happening across their extended social circles" (Przybylski et al. 2013:1842). Some scholars study FOMO purely as a psychological phenomenon without explicit attribution to any specific media. However, some conceptually assign FOMO either in connection with social media usage or in connection with a specific device such as smartphone. Some scholars examine FOMO as a part of Internet addiction. The social aspect of FOMO remains undisputed throughout the whole literature: "the social aspects of FOMO distinguish it from post-decision regret: it is specifically about missing out on experiences that others are having" (Milyavskaya et al. 2018:726). Moreover, authors' findings suggest that FOMO is an inherently social phenomenon inasmuch as people experience less FOMO when they are

engaging in an activity with another person, and more FOMO when the alternate activity is social in nature. Below is a short summary of each of these four perspectives and a take on how they are connected.

FOMO as an independent psychological phenomenon

Even though FOMO is widely understood as a phenomenon of technological distractions, while investigating FOMO on a conceptual level and distinguishing FOMO from general self-regulation, scholars suggest that there is a larger scope to the phenomenon of FOMO, and that FOMO can likely be experienced without the involvement of social media (Milyavskaya et al. 2018:726). In literature, FOMO is studied within SDT's Basic Needs Theory. The suggestion is that FOMO is a mechanism developing from situational or chronic deficits in psychological need satisfactions. The concept of FOMO as a technology-independent psychological phenomenon is applicable to smartwatch users as the usage can be provoked by the need of relatedness and belonging.

FOMO & the Internet

As underlined before, FOMO is studied as a deeply social phenomenon that is either created or catalyzed by the Internet. Within CIUT, FOMO is a reaction used to balance out the negative feelings by going online and satisfying social needs. Smartwatches can be connected to the Internet either directly via SIM-card or WiFi or through the short-range connectivity via smartphone, even though it is not a required condition. To access the full functionality, namely the communication features and applications that require Internet connection (such as weather or music streaming applications), one would need to connect the device. The features that could potentially be used without Internet connection mainly consist of self-tracking – measuring and reporting. Otherwise, some timekeeping functionality is available to users such as a timer, a stopwatch, and an alarm. In summary, not all smartwatch-related activities are covered by the approach to FOMO within the CIUT, as smartwatch can in some cases be used without an Internet connection. However, smartwatch usage without an Internet connection does not automatically mean an absence of FOMO, as some functionality is still available without it. These applications are going to be discussed in the following section.

FOMO & social media

Most often, however, FOMO is approached in a link to social media. FOMO could be viewed as a predisposing factor within the I-PACE model to develop excessive social media use. Social media applications are accessible on smartwatches, even though the functionality differs from the features available on other devices. While alerts about incoming messages are available on a smartwatch in the form of push notifications, the applications are rather limited in terms of outgoing content (Ha et al. 2017:1271). Most smartwatches do offer a function of replying via dictation function through microphone as well as some prepared answers, due to the screen size this functionality is not particularly user-friendly. Moreover, such actions as scrolling the feed and reading longer texts, posts or blogs are either not available or very limited at the time of the research. Furthermore, similarly to the Internet connection, people do not have to use these functions as smartwatches can be utilized without it, for self-tracking and timekeeping functionalities.

FOMO & smartphones

In rare cases, FOMO is studied in link with smartphone usage. Clearly, if FOMO would be conceptualized by some scholars exclusively as a smartphone-related phenomenon, it would not apply to smartwatch users. The question in the framework of this research therefore is if the FOMO concept can be applied to devices other than smartphones. Smartwatches are mostly used as an extension of a smartphone and only seldomly alone (Henriksen et al. 2018:3). Some scholars even go as far as naming smartwatches a "smaller version of a smartphone" (Chuah et al. 2016:277). This topic is going to be unfolded further in the next section.

To sum up, FOMO is conceptualized in the framework of several theories and models, SDT is one of the most used in FOMOresearch. This section included a discussion of the I-PACE model and CIUT as well, with the goal of establishing whether the FOMO concept could be applied to smartwatches in the framing of these theories.

An important criterion can be deducted while investigating whether the concept of FOMO can be applied to smartwatches and smartwatch users: FOMO is a deeply social phenomenon and applying the FOMO concept on smartwatch users satisfies this criterion as wearable devices provide the possibility to receive alerts from communication applications and be in touch on social media.

To conclude, there are no contradictions to the FOMO concept being applied to smartwatch users within the theories mentioned above if one uses the full functionality of the wearable device, including being connected to the Internet and utilizing social media and other communication applications. However, the FOMO concept within the SDT is the most widely applicable considering diverse applications smartwatches have. These special features are going to be discussed in the section below dedicated to smartwatch research, exploring how the FOMO concept can be expanded to be applied to smartwatch users.

2.1.1 FOMO Measurement

The topic of separate significance in FOMO research is a data-driven approach to FOMO, including the measurement of individual differences in FOMO and its levels. Several approaches and scales were developed in literature to assess FOMO.

The original self-reporting 10-item Likert-type FOMO scale was developed in 2013 (Przybylski et al. 2013:1842-1844,1847) and remains the most widely used (Elhai et al. 2021:204). It is a self-report assessment that measures the FOMO construct as an individual difference and uses such statements as "I fear others have more rewarding experiences than me", "I get anxious when I don't know what my friends are up to" and "When I go on vacation, I continue to keep tabs on what my friends are doing" (Przybylski et al. 2013:1847). The scale is claimed to be sensitive to identify those who evince low, moderate, and high levels of fear of missing out construct (Przybylski et al. 2013:1844).

Further, the FOMO scale was tested in cross-cultural research, for instance in Turkey (Can and Satici 2019:5), Italy (Casale and Fioravanti 2020:5), Bosnia and Herzegovina (Tomczyk and Selmanagic-Lizde 2018:547) and others (Elhai et al. 2021:204).

Besides that, Italian researchers came up with a two-factor solution of the FOMO scale, dividing the items and adding dimensionality. They noted that the first four items in the original scale related to the fear that others are having more rewarding experiences or are having fun without the subject, while the other six reflect ruminative thoughts and strategies to maintain control over what is going on around them (Casale and Fioravanti 2020:5). The first factor aligned more with the conceptualization of FOMO, reflecting "people's fears and worries about being out of touch with experiences across their extended social environment", while the second factor is supposed to reflect cognitive/behavioral dimensions of the FOMO (Casale and Fioravanti 2020:5).

As mentioned above, FOMO can occur even without any digital media-related context, however, it is suggested that the Internet, social media, and digital device usage can trigger and increase FOMO. In literature this duality is studied by adding another dimension to FOMO. Scholars divide the concept into trait-FOMO – a personal predisposition to develop FOMO, and state-FOMO – a specific FOMO aspect that refers to other users' online activities. The latter is the effect Internet brings to the trait-FOMO: with a constant stream of events and possibilities, users objectively can miss out on more relevant conversations and events. Trait-FOMO is claimed to be measured by five items of the original scale. To measure state-FOMO some items from the original scale were modified to fit an online-context and extended with some additional state-based FOMO content (Dhir et al. 2018:35–36). It consisted of five new items that included, for example, such statements as "I am continuously online in order not to miss out on anything" and "I continuously consult my smartphone, in order not to miss out on anything" (Dhir et al. 2018:36).

While studying social media engagement, an extended 18-item scale was created (Alt 2015:114, 2017:395–96, 2018:132) to reflect the categories of engagement. The authors identified three dimensions of SME: social engagement, referring to sharing personal information with the close social environment; news information engagement that includes all news-related activities; and commercial information engagement that at the time of research included getting or sharing updates in commercial area, such as current discounts or sales (Alt 2015:114). To measure FOMO in accordance with the SME dimensions, eight items were added to the FOMO scale. It was assumed that the original scale measured the social engagement, therefore four new items were added to measure the extent to which people feared missing out on news information, for instance, "It bothers me when my friends know what's happening on the news ahead of me". The other four additional items were added with the goal of measuring the extent to which people feared missing out on commercial information, for example: "When I go on vacation, it is important to me to continue following commercial information (e.g., current discounts/sales, available coupons)" (Alt 2015:114). The findings of this research suggested that different forms of media engagement follow different FOMO trajectories (Alt 2015:118). This suggestion will be applied when analyzing the applicability of FOMO on smartwatch media engagement.

Even though FOMO as a sociopsychological phenomenon poses some problematics in terms of measurement, it is important to investigate the ways to assess FOMO as it allows not only

to make statements about how many people are affected and what the consequences might be, but also about the phenomenon itself. By examining the FOMO scales the analysis of the conceptualization started in the section above will be continued.

To investigate the first research question and the interrelation between wearable technology and fear of missing out, it needs to be established if the FOMO concept is applicable for wearable devices and specifically smartwatches. The FOMO scale is an instrument that has proven reliability in multiple cultural and academic contexts, and testing if it would apply to smartwatches will provide further insights.

The original FOMO scale (Przybylski et al. 2013:1842-1844,1847) is aimed at measuring the latent dimension of FOMO and does not link FOMO to any device. Therefore, the original scale could be applied to assess smartwatch users' inclination to experience FOMO.

The Italian two-factor solution of the FOMO scale poses no contradiction to smartwatch usage, as the fear that others may have more rewarding experiences can occur independently from the device used. Ruminative thoughts and strategies to maintain control over what is happening can be triggered by smartwatch usage or trigger behavioral changes. That means that users can adopt a certain strategy in relation to take control of what is going on around them in the social environment, such as turning on push notifications to stay alert to new messages. The two-factor solution works for smartwatch usage and could be applied to measure FOMO levels of smartwatch users.

Regarding the division in trait-FOMO and state-FOMO, the following conclusions can be made based on the fact that smartwatches are devices that work primarily, however, not exclusively, in connection to a smartphone and therefore the Internet. While trait-FOMO as a predisposition is not linked to any device usage, it is possible that what scholars describe as state-FOMO can be triggered or increased by the consumption of online content. Smartwatches provide quick access to messages, conversations, and alerts about the events that one could possibly miss out on. The features that distinguish smartwatches from other devices that contribute to state-FOMO will be discussed in the next section. Altogether, the expanded FOMO scale measuring not only trait-FOMO but state-FOMO in link with digital technology and online usage can be applied to smartwatches if users connect their wearable device to the Internet.

As mentioned above, smartwatches can be used to access social media services, therefore, the extended 18-item FOMO scale that reflects engagement categories could be used in relation to smartwatches as well. Just like in the example above with trait-FOMO and state-FOMO scale, the extended 18-item SME specified scale can be applied in case smartwatch users connect their wearable device to the Internet and social media. The three dimensions of SME identified by the authors are available on smartwatches: users can have social engagement with their social circle via pre-installed messengers and additionally installed chat applications. They can activate alerts for news and commercial information that can come in the form of e-mail newsletters, audio and video content and, again, chat applications. It must be mentioned, however, that social media consumption on a smartwatch differs from one on a smartphone: the variety of applications available and their functionality is limited on a wrist-worn wearable with a smaller display. As stated previously, the smartwatch is a device that is used in addition to a smartphone, and contents such as long texts and videos are going to be consumed on the smartphone. Smartwatch plays therefore a mediating role by providing an alert in the form of push-notification informing about the social media content and redirecting the attention to the smartphone for the final engagement. This mediating role will be discussed in further detail in the next section.

To sum up, most FOMO scales used in literature at this time could be applied to smartwatch users in most cases. Whether the existing scales would be sufficient, what needs to be added or accounted for will be discussed in the following section.

2.2 Smartwatch Characteristics

This section is dedicated to smartwatch research. The research on wearable devices and specifically smartwatches is in its infancy and is heavily overflown by product reports from producer companies. Academic research mostly focuses on customers' perceptions (Anggraini et al. 2019:1273). This section characterizes the approaches taken to study smartwatches and draws focus on key differentiating features that play a role in relation to the research question.

There are several theoretical frameworks that are applied in the literature to study smartwatch use. Some scholars claim the applicability of the Expectation-Confirmation Model (ECM) for smart connected devices and smartwatches (Siepmann and Kowalczuk 2021:806) and study the continuance intention of smartwatches (Nascimento et al. 2018:159). Sometimes a combination of acceptance-related theories is created, including

diffusion of innovations theory and flow theory (Hong, Lin, and Hsieh 2017:265). Other scholars show that user behavior is influenced by technology readiness (TR) as post-adoption behavior will depend on it (Son and Han 2011:1181).

When studying purchase intention, literature draws on the theory of reasoned action (TRA), that is claimed to be able to provide insights into smartwatch vendors to develop their new products and marketing strategies (Hsiao and Chen 2018:110).

When studying adoption, technology acceptance model (TAM) and some variations are applied (Choi and Kim 2016:779; Chuah et al. 2016:277). Sometimes, to study the intention to accept smartwatches, a combination of the unified theory of acceptance and use of technology (UTAUT) with other acceptance-theories mentioned above is used (Wu et al. 2016:385).

Even though this research does not fit into any of the directions that smartwatch research is usually approached by it is important to acknowledge the theoretical framework these wearable devices are studied within. These theories are going to be considered when building the conceptual model later in this chapter.

The goal of this section is to discuss the applicability of the FOMO concept to smartwatches. Because FOMO is mostly studied on the example of smartphones, the idea behind this process is to address the differences, relevant to the FOMO research, between wearables on the example of smartwatches in a conceptual and practical level and other digital devices such as smartphones.

To a large extend, smartwatches are a part of device ecology (Cecchinato, Cox, and Bird 2017:1), that is used in connection with other devices and only rarely alone. The smartwatch has some functional similarities to a smartphone and some researchers find it to be an extension of the hand-held device. Smartwatches, when used in tandem with a smartphone, offer the same functionalities for receiving information but in a quicker and more convenient way (Visuri et al. 2017:7).

When it comes to the differences between smartwatch and smartphone usage, a study shows that users interact with notifications on smartwatches faster than on a smartphone and are generally less likely to miss a notification due to cues being more obvious (Visuri et al. 2017:7). User sessions on smartwatches were found to be generally shorter than on a smartphone (Visuri et al. 2017:6), however, because smartwatches are easily accessed and

one does not need to go through the physical procedure of digging into his or her pocket or bag for the device, smartwatch users have on average 142.1 sessions per day, while smartphone users were identified to have an average of 60.1 sessions per day (Visuri et al. 2017:6–7). The authors explain the differences primarily by functionality of smartwatches. These devices are more suitable for consumption rather than generating new content due to their limited input options. Additionally, a smartwatch is a timekeeping device which adds to the number of short interactions. However, also such factors as accessibility of the smartwatch and the fact that smartwatches are not yet that widely spread compared to smartphones, which results in users being more likely to be technology enthusiasts, contributes to the differences between these devices (Visuri et al. 2017:7). In terms of types of interactions with the applications, the study shows that the same notifications resulted in a similar style of interaction on both types of the devices. The notifications from "Communication", "Internet and Social", or "Other" general categories of applications were more likely to receive some interaction, while such categories as "Productivity and Admin", "Maps and Travel", "Media", and "Health" received more peeks or glances.

The topic of messages and notifications is especially relevant for this research as it is directly connected to the fear of missing out. Due to the fact that a smartwatch screen is too small to consume media actively, most of the usage is going to fall on the interaction with the incoming correspondence. How users interact with it depends on their device settings and personal response.

Wearable technology "ensures that information can be constantly "pushed" (…) from a cellular or WiFi network" (Gilmore 2017:193). Therefore, wearing a smartwatch with any notifications active automatically means being available for notifications for this time. One can take control of what notifications to allow, then when to wear a smartwatch and then by adjusting the response pattern – that does not stop with smartwatches. After receiving the notification, the user can either ignore it, dismiss it, or read it. Reading can be done on the smartwatch or on some other device already. As the final step, one may decide to reply, which can sometimes be done on the smartwatch itself, depending on the device model, or on some other device in the ecosystem (Cecchinato et al. 2017:6). This availability management is represented in Figure 1.

Two main elements that distinguish smartwatches from devices FOMO was previously studied on can be identified.

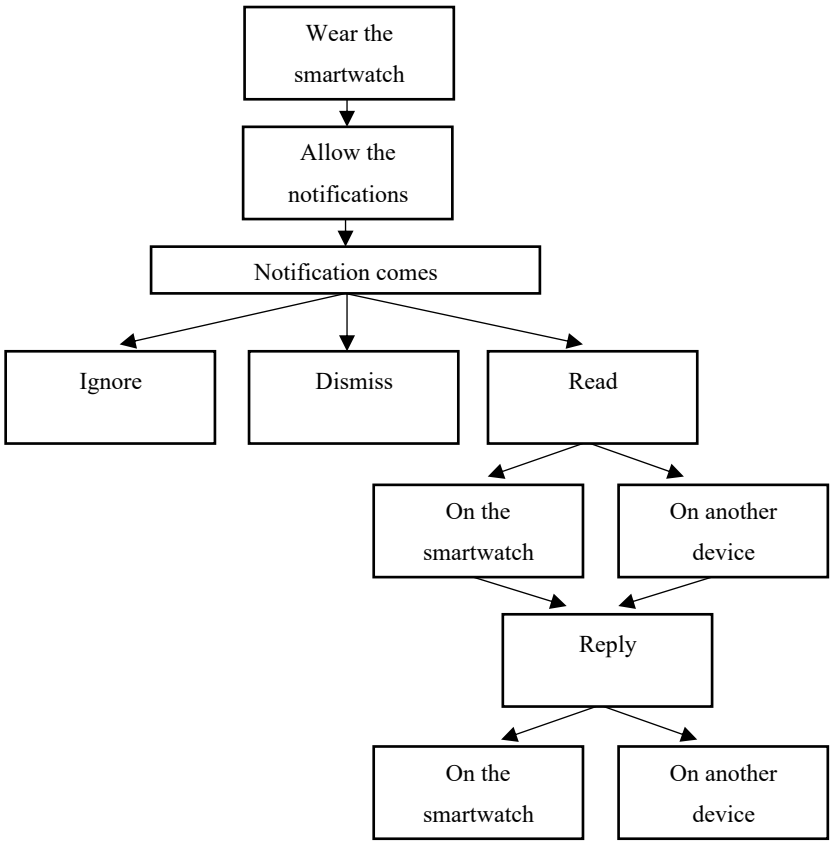

Figure 1. Managing availability (own representation based on Cecchinato, Cox, and Bird 2017)

On the one hand, there is the functionality provided: smartwatches possess similar functionality to smartphones in terms of connectability and information supply. However, with reference to the features mentioned above, technical content of the device can be employed to execute additional functions in the form of biodata collection and processing.

On the other hand, there is the method of utilization: smartwatches are per definition wrist-worn devices that during both active and passive use reside in unprecedented direct and constant proximity to one's body and skin. This results in firstly, ubiquitous availability of users, and secondly, the haptic dimension of receiving alerts and staying in touch. While the first one can arguably be achieved by simply carrying other devices constantly and paying attention to them, the second is beyond reach with other devices. Whereas smartphones and tablets may employ vibration as a form of notification, it is directed at grabbing user's attention by producing a sound, and not (or just rarely, in case of smartphones) to physically nudge.

These two main distinguishing areas are going to be engaged with in the next sections.

2.2.1 Self-tracking

A useful feature of high importance which wearable technology provides is the possibility to execute self-tracking. It is relevant to mention because tracking one's daily step count (Statista 2020b:19) as well as general fitness and health (Deloitte Deutschland and INHORGENTA MUNICH 2021:15) were named to be the main reason to use wearable devices. Users indicated that self-tracking of diet regulations, sleep patterns and consumption habits are the most liked features of their smartwatches, partially because they are only available to such an extent with wearable technology (Koo and Fallon 2018:12).

Self-tracking, or self-monitoring is not a new technique and was practiced in clinical settings well before the PI (Personal Informatics) technologies (Rapp and Cena 2016:2). However, wearable technology provides a set of tools such as movement sensors to perform self-tracking in a user friendly and engaging way. Rapp and Cena (2016:3) summarize different PI tools across a variety of domains, that can track gather data related to mood and emotions, daily tasks, movement and locations, dreams, finance, and so on. They divide the PI instruments into those that track data automatically by sensors and those that rely on users' active self-reporting – for example, self-logging. They further analyze the type of data collected and divide it into six categories: psychological and physiological parameters, symptoms, behaviors, management of daily tasks and, location/movement tracking. Most of the PI tools are related to tracking health, wellness, and fitness metrics but there are also ones in self-management and transportation domains.

Self-tracking has several other names in the literature, such as personal analytics, personal informatics, self-surveillance, self-quantification (SQ) and similar (Almalki, Gray, and Martin-Sanchez 2016; Li, Dey, and Forlizzi 2010). (Rooksby et al. 2014:1167) suggest a term "lived informatics" and propose five styles of personal tracking. They found that directive style refers to goal driven tracking, documentary style is less impregnated by desire to change, diagnostic tracking is characterized by "looking for a link between one thing and another" (Rooksby et al. 2014:1168). Gamification of modern technology is the drive for tracking in order to collect rewards, score points or register achievements. Lastly, pure interest in technology is the cause of so-called "fetishized [sic] tracking" (Rooksby et al. 2014:1169). In the literature, self-quantification was indicated as a focal construct in understanding continued smartwatch use (Siepmann and Kowalczuk 2021:806). Self-

quantification and goal pursuit motivation were both found to be important antecedents of perceived usefulness and satisfaction. Furthermore, self-quantification was determined as a driver of goal pursuit motivation (Siepmann and Kowalczuk 2021:806).

Scholars describe two core aspects of personal informatics: data collection and reflection on it (Li et al. 2010:558). Even though there has been found a lack of clear definition and description of interaction between users and their health SQ data (Almalki et al. 2016:4), it is claimed that PI "help people collect personally relevant information for the purpose of self-reflection and gaining self-knowledge" (Li et al. 2010:558). This is especially relevant in the context of evaluation whether the concept of FOMO can be applied to smartwatches because many technologies inform people about the world, while personal informatics systems inform people about themselves (Li et al. 2010:557).

Self-tracking is a distinguishing feature for wearables that adds value to consumers. However, the collected biodata has a potential to be shared and utilized further, which creates privacy concerns among users.

From early on, researchers acknowledged the conflict between security and privacy concerns (Starner 2001b:58). Whether users of wearables see a concern over personal data sharing as a key issue is a question. Some users believe in sharing their results and data with friends and family, and this is what motivates them to achieve the goals that wearables help them to aim for (Ericsson 2016:9). However, because the information collected by wearables is highly sensitive, it creates a negative attitude towards the technology. Scholars underline that the information collected by "haptic technologies" creates "a comprehensive documentation of a person's identity and body - this not only includes their intimate practices and desires, but can also include their body shape, temperature, texture, and heartbeat" (Ley and Rambukkana 2021:9). As a result, even though the technology offers benefits, some users perceive it negatively. For instance, a survey from 2017 on health sensors on the body or in clothing showed that Austrians are rather skeptical of wearable health sensors. A total of 31 percent of those surveyed stated that they viewed sensors on the body or in clothing for the permanent monitoring of the state of health very negatively and another 14% said it sounds unrealistic (Statista 2020b:17).

However, the focal question within this research is what implications self-tracking function of smartwatches has in terms of FOMO.

It has been claimed that similar to SMS communication physical self-tacking such as step count is among other a social activity (Rooksby et al. 2014:1170; Vyas et al. 2020:632). Self-tracking activity shared in a group provides connection and motivation (Vyas et al. 2020:637). As discussed above, social nature is one of the main factors that characterize FOMO. Within SDT and CIUT the desire to satisfy social needs can lead to developing FOMO, creating the anxiety to be out of touch about the activities someone within their extended social circle is pursuing.

While self-tracking and the following self-reflection is in general a positive drive to set and achieve some self-improvement goals, it can also lead to rumination — anxious, perseverative cognition focused on negative aspects of the self, defined as "thinking deeply or repetitively where that thought pattern is directed in a negative, unprogressive way, which makes individuals get stuck in a negative cycle and unable to problem-solve or act in their own best interest" (Eikey et al. 2021:604).

FOMO is usually studied in link with social media, as a fear to miss out on something that someone else might be doing. However, self-tracking capabilities of smartwatches added another dimension of 1. activities people might miss out on and 2. notifications communicating some information with them. The notifications can come either from a member of the circle one shares self-tracking activities with or from the smartwatch itself. The rumination mentioned above can be seen as the result of pressure perceived in connection to the desire to stay "on top" of the goals and activities one set for themselves or in a social context and be a type of FOMO.

In the framework of this research, it is suggested that because self-tracking activities satisfy the FOMO concept by either being social in nature or being an activity people may feel like they miss out on, the FOMO concept could be applied to these pursuits. Hence, SQ adds another dimension to FOMO as alerts informing a user can come both from other people in their circle and from the device itself, notifying the user not only about the world but about themselves. This assumption fits within the SDT as people want to satisfy their psychological needs in terms of competence and relatedness by achieving the self-tracking goals and connecting with others. In the literature SDT was previously interconnected to UGT, by linking users' media gratifications to psychological need satisfaction (Ang et al. 2015:25) and these were proven to predict engagement in fitness applications (Klenk, Reifegerste, and Renatus 2017:183). Therefore, it will be assumed that the rumination and

anxiety connected to missing out on self-tracking achievements is a part of FOMO concept as it fits the framework FOMO is studied within.

2.2.2 Interactivity & Haptic Instants

Wearable technology is inherently interactive. While for human communication in general it is stated that interaction "takes place in a social and cultural environment rather than in a biological or physical environment" (Seifert 2008:14), the question arises, what interaction means in link with communication technology. While scholars put emphasis on a certain aspect of interactivity relevant to their research, an inclusive definition that ties all the domains together says that interactivity means "the degree to which a communication technology can create a mediated environment in which participants can communicate (…) both synchronously and asynchronously, and participate in reciprocal message exchanges" (Kiousis 2002:372). Additionally, regarding human users the concept refers to the "ability to perceive the experience as a simulation of interpersonal communication and increase their awareness of telepresence" (Kiousis 2002:372).

Digital wearable technology is even more personalized and interactive than other technology types as is goes beyond audio and video signals and offers "haptic communication" through "digital touch" (Ley and Rambukkana 2021:4) – vibration or haptic pulses that communicate directly to the user. The key feature of smartwatch technology is therefore described as "haptic instants"—or the pushing of information to the smartwatch through a series of budges, nudges, taps, or other simulated haptic sensations (Gilmore 2017:190). New haptic communication and haptic interaction are communicating the notifications on a different level of closeness to the skin – even though a smartphone might have vibrated in one's pocket, it was rarely directly touching the skin. This closeness of notifications can also contribute to the sensations one gets and have an impact on FOMO. "A text message accompanied with a vibration, for example, is a communication method that incorporates haptics and can cause an affective, even intimate, response in the recipient. When feeling a phone buzz, a person may respond with a jolting sensation of surprise, excitement, or dread depending on their context and/or expectations" (Ley and Rambukkana 2021:4).

Touch is conceptualized in different and sometimes incompatible ways in each discipline (Jewitt et al. 2020:27). For example, combining the fields of digital intimacy and platform studies, Ley and Rambukkana (2021) draw special attention to the necessity to negotiate

haptic features (Ley and Rambukkana 2021:12) and open a discussion about the ethics of digital consent.

On a technical level, there are multiple directions of studies of information transmission through tactile sense alone, that set ambitious goals of upgrading the functionality of the vibrations. For instance, the next step for smartwatches would be to provide such variety of haptic pulses and vibrations that users would be able to distinguish the informational category only by the haptic pulse (Yim, Sim, and Kim 2019:13).

The question within this research is what implications digital touch has in terms of FOMO.

As mentioned above, the main outcome of the haptic notifications is the instant alert that increases the availability of the user as well as the feeling of intimacy on the one hand and urgency on the other hand it creates. Through "digital touch" people develop and express intimate relationships using digital technology, creating "digital intimacy" (Ley and Rambukkana 2021:2). What is meant by that are special features smartwatch users have – sending signals in a form of touch that is going to be recreated on the receiver's wearable device in form of a special vibration.

Mostly, haptic communication is used to draw users' attention to push notifications, that influences their use pattern. Most of the users use smartwatch for "glimpses" and more than half of the sessions are so-called peeks - sessions shorter than 5 seconds. Between sessions initiated by user and those initiated because of a notification, notification-initiated sessions are longer (Visuri et al. 2017:6).

To conclude, within this research it means that notifications on the smartwatch are even more prominent as compared to smartphone. This does not contradict the fact that the concept of FOMO can be applied to smartwatches. However, it underlines the importance of studying the notification response users have.

To summarize, this section provided an analysis of relevant literature with the goal of establishing whether the FOMO concept is applicable to smartwatches, and a discussion on the features unique to smartwatches. Findings of the literature review and analysis show that smartwatches are similar to smartphones in functionality and use patterns but have their unique features. They consist of the following conclusions: 1. Smartwatches are not stand-alone devices and are mostly used in connection with other devices such as smartphone 2. A big part of smartwatch usage falls on self-tracking 3. Smartwatches create an increased

availability of users due to proximity to the body and haptic communication. FOMO can be applied to smartwatch users if such unique features as SQ will be accounted for, extending the FOMO concept.

2.3 Conceptual Model

In this section the findings from the literature review and analysis conducted will be applied to create a conceptual model for the empirical part of this research.

To sum up the findings of the section above, FOMO is claimed to be a social phenomenon that could occur independently from device use. Internet usage and SNS are sometimes seen as catalyzers in the way that they spread previously private knowledge of what others are doing. Most importantly, the social nature of the FOMO phenomenon needs to be accounted for.

In terms of applicability of the FOMO concept to smartwatch usage the findings suggest that the way FOMO was conceptualized until now is applicable to smartwatch users and the following assumptions can be made to extend it.

Firstly, the usage pattern of smartwatch users differs from the one studied on the example of smartphone users. Smartwatches are mostly not suited for certain activities in the lens of CIUT as one will not, for example, read blog posts or scroll social media feeds on the small screen of the wearable. Most of the functions a smartwatch offers in terms of social media and Internet activities are limited to information receival. Moreover, smartwatches can be used without any Internet connection. In that case only the remaining functionality – self-tracking activities – determines FOMO in link with the SDT.

Therefore, secondly, the self-tracking abilities smartwatches offer need to be accounted for. That means that beside social media activity and Internet use, smartwatches offer another activity that can be pursued socially or missed out on. Moreover, SQ adds another dimension to FOMO as one can miss out on something a wearable is communicating about oneself beside the usual human-to-human communication about the outside world studied before.

Thirdly, with the positioning of the smartwatch and haptic communication it utilizes, one can receive notifications immediately as they come and can choose a response pattern according to the information retrieved from the notification alert. Beside the availability

management depicted in Figure 1, there is a potential to customize the settings in a "user-driven choice" to not be constantly available (Visuri et al. 2021:545).

In both the I-PACE model and CIUT situational and environmental factors play an important role, and in the context of smartwatches these factors are a part of usability proposition. As discussed above, wearable devices were conceptualized as contextually adjustable. Current studies show that environmental problems that concern how the situation and circumstances in which the user interaction takes place impacts his/her interaction are still present. And even though it is one of the smallest groups of issues, these problems' impacts of the problems tends to be higher (Motti and Caine 2016:5). However, situational factors will not be taken into the conceptual model as they are neither unique to smartwatches nor a significant component of FOMO research.

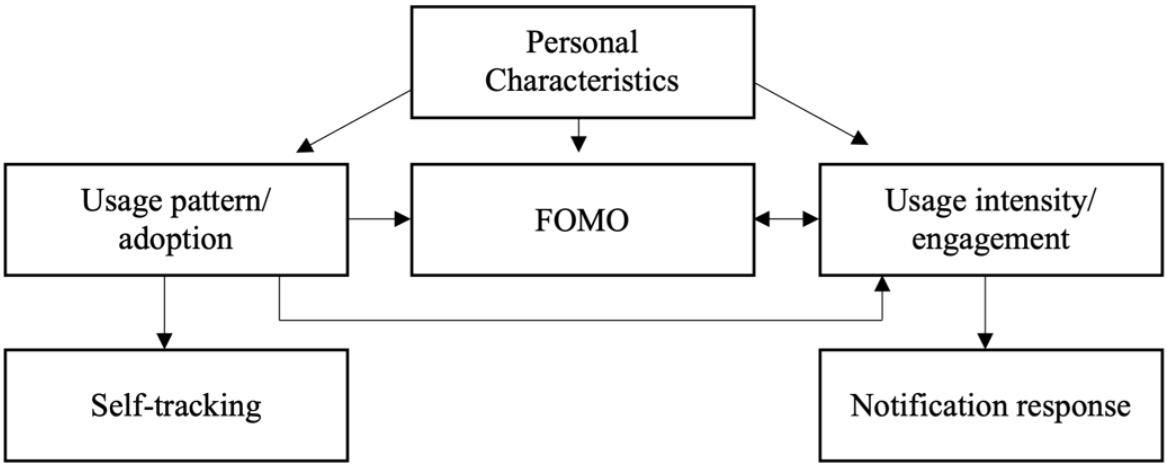

Figure 2. Model 1. The conceptual model of the proposed framework

Based on the analysis above, for the FOMO concept to be applied to smartwatch users the following model was created, as shown in Figure 2.

Because the FOMO concept within the SDT is the most widely applicable considering diverse applications smartwatches have, it will be taken as the core of the model. Within SDT FOMO is seen as the „self-regulatory limbo arising from situational or chronic deficits in psychological need satisfactions" (Przybylski et al. 2013:1842). Therefore, FOMO is in the center of the model, influenced by the personal characteristics and having a direct impact on usage intensity. In the model, smartwatch usage is divided into the usage pattern – the stage of adoption of the wearable technology devices that changes over time (Visuri et al. 2021:544) and usage intensity – the level of engagement with the devices. FOMO can have a mediating effect between the usage pattern and the usage intensity. This assumption is

based on the previous findings in the literature, where FOMO was described as an "informative metric" (Baker et al. 2016:280) that determines the difference between problematic and non-problematic use.

Personal characteristics have a direct impact on FOMO, the usage pattern including the level of adoption, and usage intensity or engagement with the wearable technology. "Personal characteristics" is a collective term used for the personal needs that are a part of Basic Needs Theory of SDT, the personality traits that play a role within I-PACE model and the personal situational factors that relevant with a backdrop of CIUT. The self-tracking feature of smartwatch that was identified as a unique trait of wearable technology is a part of usage pattern.

The response to the notification that is altered by the increased level of interactivity due to the haptic instants provided by smartwatch, and therefore falls into the device usage intensity category. The proposed model is based on the research interest of the paper and focuses on the relationship between smartwatch usage and FOMO, and therefore does not concern specific outcomes of FOMO on person's wellbeing or others.

This model is an attempt to structure the interrelationship smartwatch usage may have with FOMO based on the theories used to study the concept and state of research on each of the topics. In the next chapter, the first section is dedicated to the state of the art focusing on the research conducted on the research interest of this paper – the possible link between FOMO and smartwatch usage. The conceptual model will also be applied to operationalize the research questions and guide the empirical research. In the third chapter, the findings will be put into perspective based on the conceptual model and the model itself will be critically discussed.

3 Empirical research

This section describes the empirical research conducted within this study. First, the general state of the art on the link between smartwatch usage and FOMO are going to be summarized. Then, research questions defined in the beginning of the paper will be operationalized. Afterwards, methods and instruments used will be addressed. Finally, analysis and interpretation process are going to be documented with the goal of hypothesis generation. In the end, the findings will be evaluated.

3.1 State of the Art – Smartwatch & FOMO

This section summarizes the research previously conducted in connection to the interplay smartwatches have with FOMO, even though the conducted literature review shows that FOMO was not previously examined in link with smartwatches. There also was no research on the contribution the increasing variety of devices makes to strengthening of FOMO of users.

The early conceptualizations of wearable devices supposed that due to the immediacy of interface and contextual perception, the goal of "nonintrusive computer interfaces" (Starner 2001b:63) will be challenging but achievable. Moreover, acknowledging that users' attention is the scarcest and most valuable resource for wearable computing, wearables were conceptualized with the ideal of being "designed to consume [only] a fraction of the user's full attention" (Starner 2001b:61) and rather augmenting reality by overlaying "information-rich virtual realities onto the physical world" (Starner 2001a:48).

Smartwatch providing push notifications is a feature valued by users, however, it has its pros and cons. On the one hand, a German study in 2016 showed that 3⁄4 of all users expect initiative from their smartwatch, especially that it draws attention to current affairs, messages, notifications etc. and independently displays relevant information via push notification (Bundesverband Digitale Wirtschaft (BVDW) e.V., DAYONE GmbH, and defacto digital research GmbH 2016:16). On the other hand, scholars claim that because the device usage is driven by notifications, "smartwatch users attempt to be more available, but eventually see this as an unwanted usage behaviour style" (Visuri et al. 2021:544).

While studying smartwatch user experience and how it fits within existing device ecologies, (Cecchinato et al. 2017) mention attention costs as the negative costs users seem to have for saving time and not pulling out the smartphone. The study focused on the relationship smartwatch users have with notifications and have shown that people have a clear idea of what sort of notifications they want, in what way and when they wanted to be notified, and where the notifications should appear (Cecchinato et al. 2017:4). Only relevant notifications, different from notifications on one's phone, were wanted on a smartwatch. Moreover, it would be preferable if one could specify what subsets of notifications or notifications on what topic they would like to receive. Next, users expressed the wish for notifications to be contextual. However, the interpretations of what they considered contextual differed: some, for instance, were keen on having location-based notifications, and others wanted to have

different types of notifications enabled depending on the activity they were involved in (Cecchinato et al. 2017:4–5).

On the subject of how users like their notifications, they have shown to perceive it as a major benefit of a smartwatch to have an additional step in dealing with notifications. Users indicated that by a quick glance at their wrist they could decide whether to interrupt their current activity or not deal with the notification right away (Cecchinato et al. 2017:5). Some users also expressed that this "glancing" on the smartwatch is less rude as "phubbing" behavior on smartphone, that was mentioned on examples of some studies above (Balta et al. 2020; Chotpitayasunondh and Douglas 2016; Franchina et al. 2018). This response pattern as well as the ways of managing availability are especially relevant for the interpretation of the empirical results in the next section and will be mentioned in detail.

The problem of users' interruptions caused by smartwatch notifications is approached by suggesting various solutions, for instance, on the technical level such as intelligent notification management. This should be achieved by training the convolutional neural network models to classify important notifications according to the users' contexts and reduce unwanted notifications (Lee, Kwon, and Kim 2018:1–7). However, this may influence user experience which may negatively affect especially users who prefer customizing their notifications by themselves in particular (Cecchinato et al. 2017:4–5).

To sum up, this section listed the research that indirectly mentioned the factors that constitute the relationship between smartwatch usage and FOMO to some degree. From early conceptualizations of wearable technology, the price of the limited good which users' attention is, was acknowledged. Moreover, wearables were thought to conquer the problem by augmenting reality and minimizing distraction. Partially this became true as users see value in short alerts that they can unobtrusively read. However, some findings suggest that attention costs are still too high as incoming notifications cause distraction and users tend to be more available due to smartphone, which they perceive as negative. Finally, solutions to reduce interruptions were mentioned. These include intelligent notification management enabled by neural network models that are trained to identify important notifications and customize the alerts according to user's need, reducing unneeded distractions thereby.

These findings will be considered in the final chapter where the results of the empirical study will be compared to the findings from existing research.

3.2 Research Questions Operationalization

In this section, as the first step to empirically study the topic, research questions will be analyzed with the goal of deriving a structure of the research framework of this paper. For this, each question is going to be reviewed and components will be operationalized in the second step of the process. This will form a foundation for the empirical research conducted later.

RQ1: What is the relationship between smartwatch usage and FOMO?

The main goal of this paper is to explore the interrelation between wearable technology on the example of smartwatches and the fear of missing out. The question of whether and how the FOMO concept can be applied to smartwatch usage was primarily investigated on the conceptual and theoretical level in the second chapter of the paper. The analysis will be expanded based on empirical research in this chapter.

RQ2: What is smartwatch-users' specific response pattern behavior in relation to FOMO of notifications?

To examine this question, qualitative research will study behavior modifications related to smartwatch usage. Because smartwatches possess the unique traits discussed in the chapter above, and namely that smartwatch usage is characterized by technology-specific usage behavior, such as the usage of self-tracking technologies and certain response pattern to notifications due to haptic communication, they will be analyzed in-depth. Based on the conceptual model derived for this research (Figure 2), usage pattern and usage intensity specifically are to be explored for this research question, with particular focus on the notifications and notification response.

RQ3: How does self-tracking effect FOMO?

As mentioned above, one can track psychological and physiological parameters, symptoms, behaviors, management of daily tasks and others (Rapp and Cena 2016:3). The knowledge self-tracking and self-reflection delivers is unique because, firstly, it is built on machine-to-human notifications that, secondly, inform people about themselves (Li et al. 2010:557).

Therefore, the core components to inspect within this question are the smartwatch usage patterns and self-tracking habits.

Based on the considerations presented above, in addition to the FOMO concept addressed in the chapter above, the following four core concepts will be operationalized.

Usage pattern refers to the suggestion that usage behavior changes over time (Visuri et al. 2021:544) and is a combination of diversity of use cases, awareness and control over technological features as well as the level of adoption that reflects the experience level. In literature, usage pattern is studied by dividing the device handling in two categories: basic function usage and innovative functions usage (Huh and Kim 2008:43). Additionally, the usage of self-tracking functionality is especially of interest. Usage pattern is the focus on how diverse the applications are, and how controlled and conscious the choice of services, applications and notifications is.

Self-tracking functionality is defined as the use of those services that fit under the umbrella of personal analytics, personal informatics, self-surveillance, self-quantification (SQ) and similar, as discussed in the sections above. These are the applications that collect and show the data to the user in order for them to "acquire self-knowledge or achieve a goal" (Eikey et al. 2021:601).

Usage intensity includes the length of active use in the moment of surveys, as well as the frequency of wear and use, meaning the use hours per day, week, or month. Additionally, such components as intensity of attachment to the device and intentionality of purchase and use can be relevant.

Notification is understood as a signal aimed to get user's attention and inform about something, including external reception of communication items or internally created information produced by the smartwatch. Due to the nature of smartwatches as wearable devices, notifications may include several sensations such as vibrations, that make "virtual information more felt and physical" (Gilmore 2017:190), sound signals, visual indications, and others. For example, the interest within this concept is whether users employ any built-in application instruments to set boundaries to the notifications. That is, it is in the interest of this paper whether the user has notification sounds on, haptic touch and vibration calibrated to the needs, and not how specifically or how often they respond to the notifications. It also focuses on the engagement with the notifications habitually, including the feelings and reactions to the incoming notification that is in part the indicator of usage intensity as visualized in Figure 2.

3.3 Method and Instrument

This section provides an overview of empirical methods considered and used in the process of this research. Beside argumentation of the method chosen to conduct the research and a brief discussion on its implications and advantages and disadvantages, this section summarizes the demographics of the target group and technological means and strategy of quality assurance chosen to be employed.

In the planning phase of this research, an online survey was intended to be conducted to validate the hypotheses in the second part of the study. However, hence the subject of the research is a sociopsychological phenomenon, the validity of an online questionnaire would be compromised. The questions demand high level of self-reflection of participants about a negative aspect of their own behavior and therefore the data collection runs into a risk of provoking socially desirable answers and turning the research into a self-fulfilling prophecy. Therefore, a qualitative study of user interviews was chosen instead.

A number of semi-structured interviews with maximum variation sampling (Jensen 2021:290,294) of smartwatch users were conducted with the goal of hypothesis generation. Participants were recruited through snowball sampling and by word-of-mouth. They completed a recruitment survey to be selected for the interview. Selection criteria included: being between 18 and 54 years old, having Vienna as one's main place of residence and using a smartwatch. For the latter, the interview also included a question "What smartwatch do you have?" – to validate that the device fit the criteria of the paper regarding the classification of wearable devices as smartwatches and fitness-trackers as described in section 1.1.2.1. The demographics of the target was determined by the distribution of users of wearables described below.

According to Statista Digital Market Outlook, around 29.8 percent of users of wearables and fitness apps in Austria were between 25 and 34 years old in 2018 (Statista 2020a:n.p.). 23.3 percent were between 35 and 44 years old and 20.1 percent were between 18 and 24 years of age. The last big cohort of users, namely 16.8 percent were between ages 45 and 54. For this research these four cohorts will be analyzed. According to Austrian governmental statistic agency, this covers 516.391 females and 518.026 males (Statistik Austria 2021:n.p.), which makes altogether about 1.03 million people. This result is also representative of an equitable share of Austrian population that consists of approximately 9 million people. To represent this population, it was decided on a sample of at least 12 participants with an even

share of female and male respondents (at least 6 of each, while the participants who wish to not disclose their gender will be assigned to a separate group). Additionally, the sample of participants must contain the representation of each of the four cohorts described above. For that, the sample must consist of at least one participant within each cohort.

Semi-structured interviews consisted of a maximum of twenty-three open questions constructed on the principle guidelines of openness, clarity and creation of the narrative flow (Helfferich 2019:677). The questions were derived from the operationalization prosecuted in the section above and included two opening personal questions about the type of smartwatch and purchase intention, five questions each about usage intensity and FOMO, as well as six questions about usage pattern and two completely open questions on what participants felt like sharing about the smartwatch. Finally, interviews were concluded with three personal questions about age, gender, and the place of residence to ensure the quality criteria of the research were abided by.

Since the interview is a communication situation in which the text is generated interactively, respondents were informed of the purpose of the interview and total anonymity during the analysis, guaranteeing that no information, name, or any personal details will be made available. They were encouraged to speak freely and honestly because the interest of the survey consisted of their personal opinions and experiences and there were no right or wrong answers. Participants were informed about being recorded and their ability to withdraw the agreement at any time.

Interviews were recorded with an either an iPhone recording application or in-build recording feature of Zoom, depending on whether the interview took part online or in a face-to-face conversation.

To analyze the interviews, two analytic methods were considered - theoretic thematic analysis (Braun and Clarke 2006) using semantic realistic approach and qualitative content analysis (e.g. Mayring and Fenzl 2019). Since the goal of the first part of research is in generation of hypotheses, which will later be examined, a thematic analysis could face the problem of providing results too broad for instrumentalization. Because the aim of thematic analysis is to open a discussion on each of the themes conducted from the analysis, it may lack precision desired in the current framework. Therefore, qualitative content analysis with

the help of QDA-software will be conducted. Content-structuring content analysis (Kuckartz 2016:181) with the use of MAXQDA2022 software was applied.

Qualitative content analysis is an evaluation method (Mayring and Fenzl 2019:634) that has a focus on systematic, verifiable procedures. This method of analysis has communication of any kind as its object of investigation. Content analysis is carried out systematically, according to a fixed, rule-guided scheme, and requires protocol. This means that the contents of the investigation should be fixed - transcribed, and the steps of analysis should be documented throughout. Furthermore, content analysis is characterized by theory-guided procedures.

The quality criteria of scientific work are of special importance in qualitative content analysis: in addition to the generally valid objectivity aimed at, reliability and validity are to be considered. There are several methods of applying the quality criteria, the examples of which are intercoder reliability - a procedure when the analysis is performed by several people and the results are compared; and intracoder reliability - when the same content analyst codes the material again at the end of the analysis without knowing his or her first codes (Mayring 2015:117). In the current research, the second method was applied. One reason for that was that the possibility to return to coding and to recode arose as the interview process took part in two sessions around three months apart. The second reason being that the research was conducted single-handedly and therefore intercoder reliability would not be a valid method as any external person would not evaluate the material with the same level of knowledge on the matter.

When conducting content analysis, it is essential to decide on a specific process model to ensure quality assurance. In this paper content-structuring content analysis (Kuckartz 2016:100) specifically was applied. It consists of seven steps: the initiating text work, which includes marking important text passages and writing memos; the development of thematic main categories; the first coding of the entire material based on these main categories; the compilation of all text passages coded with the same category and the inductive determination of subcategories on the material; the following second coding process with the differentiated categories and finally the analyses and visualizations (Kuckartz 2016:101–10).

Before that, however, the following steps have to be taken into account in order to decide what can be interpreted at all from the collected material: one has to define the material, analyze the situation in which it was created, and consider formal characteristics of the material (Mayring 2015:52–53). In the first step the population must be defined and based on it the sample should be determined. On the one hand, the size should be selected representative and economically reasonable. On the other hand, the sample must be drawn according to a certain model, for example, either randomized or according to fixed quotas. In the second step, it must be described exactly how and according to which conditions the material was produced or collected. In the last step, "it must be described in what form the material is available" (Mayring 2015:53). That is, the transcription methods and possibly used software must be documented. The protocol rules that have been decided upon must be defined and justified as best as possible. For this, the goal of the transcription and subsequent analysis method must be evaluated. Is it important to represent only the verbal features as accurately as possible by documenting the spoken word sequences? Or should the important accompanying nonverbal behaviors such as laughter be documented as well? Do the goals and questions of the study, as well as the method of analysis to be used later, require the description of prosodic - acoustic - content in terms of pitch, or the documentation of extra-linguistic behavior - such as gestures or eye movements (Kowal and O'Connell 2004:345)?

As can be seen from the process model of content-structuring content analysis, category formation is an essential part of the analysis procedure. A basic distinction is made between deductive and inductive procedures. A deductive category definition is carried out by theoretical considerations. That is, the categories in an operationalization process are developed from preliminary research, from the previous state of research, from newly developed theories or theory concepts. An inductive category definition, on the other hand, derives the categories directly from the material without referring to pre-formulated theory concepts (Mayring 2015:83). In most cases, a combination of these methods is possible; in the case of content-structuring content analysis, the combination is also desired.

The first step of content-structuring content analysis as in all forms of qualitative content analysis consists of initiating text work, writing memos and first case summaries (Kuckartz 2016:101). The latter can both be done in the form of paraphrasing for the coding process itself and serve as part of the topic matrix for the analysis later. Highlighting text passages that seem particularly important and writing memos - remarks and annotations - initiate the

content-structuring content analysis (Kuckartz 2016:101). The summaries must be based on the original statements, thus must be grounded in the empirical data in the truest sense (Kuckartz 2016:117).

In the second phase, the main categories or the main themes are derived - often more or less directly from the research question. Here again, the rule is that the appropriate method of category formation should be chosen flexibly and adapted to the material from the needs of the present research (Kuckartz 2016:102). In this step, a trial is conducted on the thematic categories on a part of the material to check their applicability to the concrete empirical material.

After that, the first coding process is carried out. Each text is worked through sequentially, i.e., line by line from the beginning to the end, and categories are assigned to the text sections. Since several main topics and sub-topics may be addressed within one text passage in content-structuring qualitative content analysis, coding may overlap (Kuckartz 2016:102). Every relevant unit of meaning is coded, which usually consists of a complete sentence. The main task during the first coding process is to determine an appropriate length of the coded text passage. The goal is that the text passage is understandable without the context and is sufficient for interpretation. For this purpose, text passages can include several sentences or paragraphs, and interview questions can be coded as well (Kuckartz 2016:104).

The next steps include compiling all text passages coded with the same category and inductively determining subcategories on the material. It is important for the process of content-structuring content analysis that the steps can be repeated as needed, but special attention should be paid to proper documentation. Definitions for the categories and subcategories should be formulated and illustrated by examples from the material. The inductive procedure must be justified and remain comprehensible for the readers.

Before it can come to the analyses and visualizations of the results, one must code the entire material in the second coding process with the differentiated categories. This completes the systematization and structuring of the material.

The analysis can be roughly grouped into two parts: a simple category-based analysis and complex qualitative and quantitative contextual analysis with visualizations. For content-structuring qualitative content analysis, QDA software is especially useful for text retrieval: a process in which one compiles all text passages coded with the same category (Kuckartz

2016:181). In addition, one can examine the relationships between subcategories within a main category and between main categories, create cross tabulations, and use visualizations, such as, for example, concept maps or progression diagrams to help identify patterns and present hypotheses and theories.

The advantages of qualitative content analysis lie in the systematic and clearly defined process model. This enables a transparent, comprehensible procedure that can be applied to diverse questions (Mayring 2005:474). In addition, this method of analysis is characterized by rule-guided procedure, which makes the adjustment of the category system to the material possible, and application of the quality criteria promotes. As a disadvantage the restriction in case of an especially open research question can be mentioned (Mayring 2005:474).

To sum up, this section provides an overview of the empirical method chosen to utilize for this research: content-structuring content analysis. In the next section, the following execution of every step according to the process model will be described.

3.4 Data Collection and Analysis

The collection of the data consisted of multiple user interviews. Fourteen qualitative semi-structured interviews were conducted in two sessions. The first session took place between January 31, 2022, and February 10, 2022, the second one between May 31, 2022, and June 13, 2022. Seven interviews took place in a face-to-face conversation and seven online via audiovisual communication software Zoom and Microsoft Teams. The interviews lasted between 8 and 19 minutes each.

To make the conversation permanently available for scientific analysis, interviews were transcribed. The aim of transcription in the framework of this paper is twofold. Firstly, to represent verbal features as accurately as possible, documenting the strings of words uttered (Kowal and O'Connell 2004:343). Secondly, to document important accompanying non-linguistic behavior such as laughter. The goals and questions of this research as well as the analysis method applied later require neither description of prosodic – acoustic form in the shape of pitch; nor the documentation of extralinguistic behavior – such as gestures or eye-movements (Kowal and O'Connell 2004:345). To transcribe the records trint.com software was used. Because one participant was interviewed in German language, deepl.com software was used to translate the text in English.

The sample consisted of six female and eight male respondents. Ten of them had an Apple Watch, the other smartwatches were Fitbit Versa 3 and Garmin models Vivosmart and 4S. Apple devices included one SE model, one Series 3 and five Series 6 smartwatches, as well as the flagship model from October 2021, Series 7. Lastly, one respondent indicated to have three Apple Watch models at the same time and use two of them simultaneously: Series 1 and Series 3.

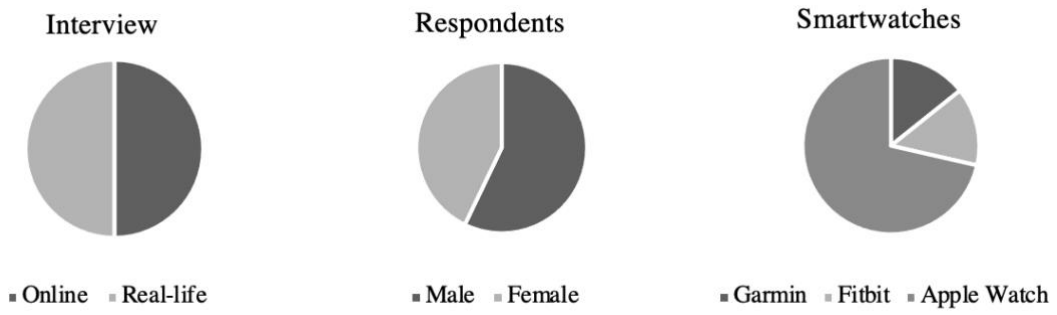

Figure 3 a: The split between real-life and online interviews, b: between male and female respondents and c: between smartwatch manufacturers in the final sample (n=14).

Based on the research questions and the collected data, the analysis technique of content-structuring (Kuckartz 2016:181) was chosen as most appropriate. The five areas of the proposed conceptual framework (Figure 2) to be analyzed can be understood as "deductive" subject areas that were specified due to the structure of the interview guidelines imbedded in the interview questionnaire. In the course of the evaluation further categories were inductively developed for these subject areas.

The procedure was conducted according to the process model (Kuckartz 2016:100) that consists of seven steps that can be repeated and executed in a not necessarily consecutive order. The model includes initiating text work, development of thematic main categories, the first coding process with the following compilation of all text passages coded with the same category and inductive determination of subcategories in the material. Finally, the process is concluded by the coding of the complete material with the differentiated categories and analyses and visualizations. As mentioned above, to apply intracoder reliability with the goal of satisfying scientific quality criteria, the material was coded one more time afterwards. After making certain the difference was less than significant (<5% of codes differing), lastly, interpretation and reporting are to be done.

First, the initiating text work, such as precise read-though and text preparation were executed. The latter included punctuation work - assigning minimal punctuation that provided readability, as well as correction work for the misspoken words – or words in another language – to make text readable. Personal information such as names was removed. No extra work to correct grammar or to delete repetitions was done with the goal of replicating the conversations as close to reality as possible. Afterwards, important passages were marked, and memos were created.

On hand of the deductive main categories and inductively developed subcategories the complete material was coded. Initially, six main categories were used for assigning the codes to the passages that belonged to the topic. These categories included "FOMO", "Use cases", "Behavior modification", "Notifications", "Self-tracking", and "Usage". These categories are deductively derived from the research questions and based on the operationalization of the concepts in the section above.

Following the first read-through, the interview responses were coded with inductively developed subcategories. For the "FOMO" category, "Being always in touch", "Checking notifications immediately" and "After checking no FOMO" were created. "Being always in touch" in turn received two subcategories: "Not being in touch" and "Being in touch can be positive and negative".

"Use cases" code was expanded by "Only pre-installed apps", "Use case: not connected to social media", "Messenger apps", "Limited apps" and "Smartwatch in interplay with smartphone".

Four subcodes were added to "Behavior modification": "Awareness due to PI", "Learning better behavior after usage", "Learning something about yourself due to PI" and "Pursuit of set goals".

"Notifications" received eight subcodes "Hard to distinguish between important and not", "Perceived little notifications/limited", "Do not disturb as remedy for notifications", "Sometimes notifications are annoying/overwhelming", "Notifications are not that annoying", "Notification nudge", "Muted is unpractical" and "Notifications on the watch to check if it is important". "Notification nudge" received three further subcategories: "Notification sound", "Notifications have physical nudge" and "Only physical nudge, no sound".

“Self-tracking” was adjusted during the initial coding process and received four subcodes: “Pursuit of set goals”, “Awareness due to PI”, “Health” and “motivation”.

Finally, for the last code “Usage” six subcategories were created: “Controlled and conscious usage”, “Length of usage”, “Frequency of usage”, “Intensity of attachment”, “Intensity of usage” and “Intentionality of usage”.

All the documents were included in the analysis and therefore all the responses were anonymously indicated. “I” stands for the “interviewer”, and speakers were numerated S1 to S14.

After the initial coding with these categories the correspondence to the coding rules was reviewed. The four main rules were re-applied and examined: it was examined that units of coding were meaningful units, with the length between one sentence and several paragraphs. Interviewer’s questions were encoded to increase understanding without the context. And how much text around the relevant information was encoded with it was reassessed. According to Kuckartz, the most important criterion is that the text passage is sufficiently understandable on its own without the surrounding text (Kuckartz 2016:104). Consequently, some codes were adjusted: some text passages were prolonged to include enough information to be understandable without the context; some codes were altered to overlap meaningfully with subcodes – subcodes should not replace codes, but rather provide a more detailed overview.

Next, categories and subcategories were analyzed to refine the code system. The final version is illustrated in Table 2. The code sets were re-examined to fit the operationalized concepts from the section above. Because the areas of the proposed theoretic framework were understood as “deductive” subject areas and were translated into main codes, the sub-codes were inductively developed based on the research question operationalization. This refinement included merging some codes together – especially if there were little segments coded – renaming some codes for a clear demarcation and creating code alias as shown in Table 3.

In the final version of the code system, the initial six codes remained, even though the codes “Use cases” and “Usage” received longer names to become clearer. Five of them reflect the conceptual model and “Behavior modification” is a high-level code that is aimed at collecting the data on the smartwatch specific influence on user behavior.

Table 2. Finalized code system including code frequencies (sum=497).

1 FOMO	31	3.2 Notification response	17
1.1 Being always in touch	13	3.3 Perception of notifications	16
1.1.1 Evaluation of being in touch	6	4.3.1 Neutral/not negative reception	8
1.2 Checking notifications immediately	13	4.3.2 Negative perception	4
2 Usage pattern/ Use cases	56	**4 Self-tracking**	42
2.1 Application use	18	5.1 Pursuit of set goals	5
2.1.1 Messenger apps	9	5.2 Awareness due to PI	4
2.1.2 Only pre-installed apps	7	5.3 Health	8
2.2 Smartwatch in interplay with the smartphone	20	**5 Usage intensity**	55
2.3 Use case: not connected to social media	3	5.1 Length of usage	16
3 Notifications	53	5.2 Frequency of usage	24
3.1 Notification nudge	13	5.3 Intensity of attachment	4
3.1.1 Notification sound	3	5.4 Intentionality of usage	15
3.1.2 Only physical nudge, no sound	8	**6 Behavior modification**	17
3.1.3 Notifications have physical nudge	6	6.1 In relation to self-tracking	8

Definitions for the categories and subcategories were formulated and documented as shown in Table 3 for the main categories, the table for the subcategories is to be found in the attachment files.

Table 3. Code alias table for the main thematic categories

Code	**Code alias**
1 FOMO	Any mentioning of behavior that indicates the "desire to stay continually connected" (Przybylski et al. 2013:1841)
2 Usage pattern/ Use cases	Any mentioning of use cases, usage of basic and innovative functions
3 Notifications	Any mentioning of notification signals from the devices
4 Self-tracking	The use of the services that fit under the umbrella of personal analytics
5 Usage intensity	Personal user experience, and perception of it
6 Behavior modification	Any mentioning of perceived change in behavior

The analysis included several procedures. Some of the tools, for instance, an analysis of sentiments per category, did not bring any findings and therefore were considered irrelevant. Others, such as code matrix, were analyzed to find out a pattern and will be described below.

The goal of the first part of the analysis is to organize all coded segments in a summary grid. Short case summaries were created to paraphrase the individual interviews and all coded segments per main category were compiled.

After the initial summarization work, the first focus of the analysis of the summary grid were usage intensity and usage pattern, the findings are presented below.

Surveyed speakers reported different length of use. However, the whole sample replied that they were users for at least several months, some multiple years in total. Altogether the respondents were users between a few months and 5 years. A group of participants indicated that their current smartwatch was not the first one they had, to be precise, one half of the users have had smartwatches previously. All respondents indicated to possess their current smartwatches for a period varying between several month up to two years.

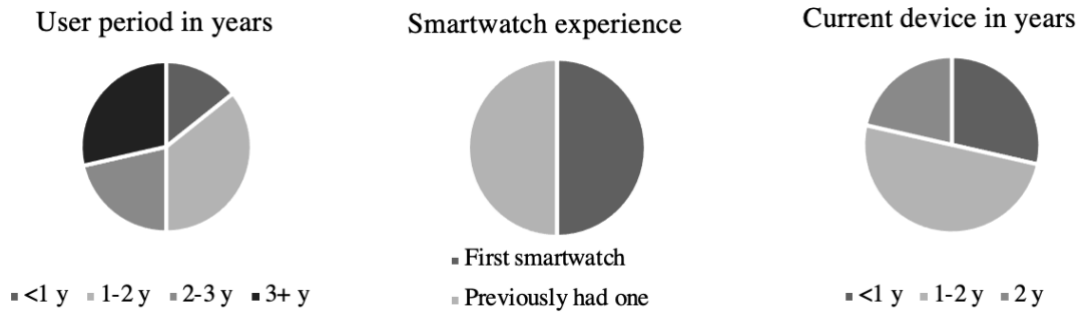

Figure 4. a: Visualization of the length of usage, b: between new smartwatch users and previous owners and c: between the length of usage of the current smartwatch in the final sample (n=14).

The participants reported vastly different usage and wear patterns. Most frequently (n=4) participants mentioned wearing the watch every day but taking it off at night. Others mentioned specific wear patterns such as workdays (n=2) or the days one leaves the house (n=1). General frequent usage was mentioned: for example, “five days a week” and “28 out of 30 days”. Regarding the usage or wear of the smartwatch at night to track sleeping patterns, the opinions differed. Some users indicated wearing their smartwatch every day and night (n=2), some - every second night (n=1), but most users said they do not sleep with the smartwatch on.

Finally, there were users with irregular wear habits. They described having pauses in use, after which one either returned to some more intense usage or not at all.

On the topic of smartwatch use cases there were also distinct responses, sometimes as individual cases due to the limited sample. Altogether six groups of features connected by functionality were determined. The first group concerns typical watch functions such as checking time, using a timer or an alarm clock. It is worth mentioning that not all participants indicated they use their smartwatch as a watch, some individuals shared exactly the opposite. The second group of functions included communication features, from usage of communication applications, receiving calls and messages to diverse notifications. Some users also mentioned the walkie-talkie function. Same as the first category, this group did not have any unity in responses – the answer varied from not using any communication features at all and having all notifications turned off to intense use – with examples of both customization and the lack thereof – of all communication and notifications features. The third big category were self-tracking features including those related to health. This category was the one present throughout all interviews, even though with non-identical focal points. Overall, self-quantification features contribute to a significant part of smartwatch usage and are one of the key use cases. Surveyed speakers reported a diversity of specific examples of self-tracking software, from fitness- and calorie-tracking, period, sleep tracking to such health metrics as blood sugar and blood oxygen levels. Additionally, monitoring of habits was mentioned, for instance, hand washing, hydration target and awareness habits such as breathing meditation. The fourth group of functions included usage of smartwatch as a remote control during audio or audiovisual playback on other devices. This includes, for example, volume and playlist control while listening to music in headphones or via external speakers. The fifth function was payment. This feature was mentioned as one of those where the interplay between smartwatch and the smartphone it is connected to was less important therefore giving the smartwatch the option of being a free-standing device. The last distinct feature mentioned was the "Find my phone" function and possibility – for Apple Watch – to unlock Apple products such as an iPhone while wearing the mask or MacBook without typing the password. These, as opposed to the previous point, were the functions that underline the use of smartwatch as a smartphone connected device or even an "extension" of the phone. A function mentioned by users that was not characterized as a use case in this analysis is the usage of the smartwatch as a fashion accessory.

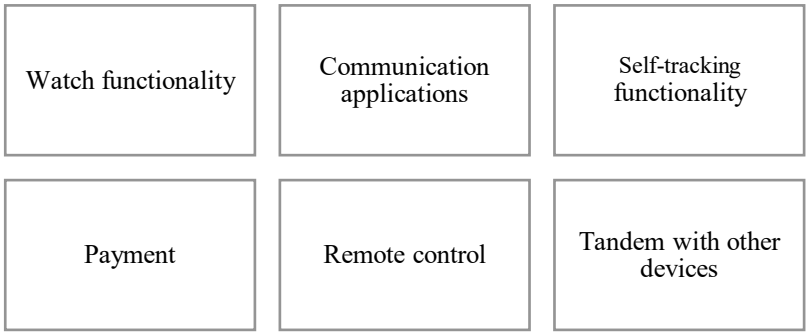

Figure 5. Visualization of six main use case categories

The topic relevant in the framework of this paper is the usage of the smartwatch in interplay with the smartphone. As discussed above there is no research on the influence of the variety and number of devices on FOMO. However, some users see smartwatches as an extension of the other devices. For them, the smartwatch is an "external display for the messaging", because one "can't (…) look at the phone every five minutes". Smartwatch is often described as not a separate device but one in an interplay with a smartphone, it is a "feature [one is] using with the iPhone". The functionality of smartwatches is used either exclusively or partially in connection to the smartphone. Even though sometimes users provided the information that their smartwatch is not connected to the smartphone, to be exact, what was meant by that is that the devices are only partially connected. As an example of that, one speaker reported using only the Fitbit app via Bluetooth but nothing else. This usage pattern results in limited performance. Due to smartwatches' functionality being finite by default, according to some speakers, the smartwatch is not an alone standing device. They say: "I cannot call anyone from my smartwatch, or I cannot text back". And answering the question whether they feel connected thanks to smartwatch, they reply that the "connecting part happens when you get on your phone". Other examples of smartwatches functioning in link to smartphones include, for instance, downloading videos on the phone through the self-tracking app to incorporate it into fitness activity and enrich user experience, or the "find your phone" function mentioned above. The latter allows smartwatches to function as an actual extension of the smartphone.

Judging based on use cases smartwatches can partially act as a replacement of the smartphone in some situations, such as payment or music replay during a workout. However, it is not expected to take the place of smartphones altogether. In relation to notifications, the smartwatch helps to not take the phone out of the pocket and aids the availability management (depicted in Figure 1).

A short overview of the case summaries using code matrix browser is presented below.

The first speaker S1 had the most hits for the codes “Usage pattern/use cases” (n=9) and “Usage intensity” (n=7). “Intentionality of usage” and “FOMO” are both on the third place (n=3).

Altogether, S1 and S4 had the most hits in a single category (n=9). For S1 it was “Usage pattern/use cases” and for S4 “Notifications”.

The most answers for S2 were coded in category “Notifications” (n=5). “Usage pattern” and “Usage intensity” and “Self-tracking” all share second place (n=4). “Notification response” and “Smartwatch in interplay with smartphone” showed high frequency out of subcategories (n=3).

For speaker S3 “Usage intensity” (n=6) and “Frequency of usage” specifically (n=4), received a lot of mentioning. “Self-tracking” was another frequently mentioned code (n=5). However, “Behavior modification in relationship to self-tracking” was also highly coded (n=4). This speaker reported currently having a high usage intensity after a pause, however, low diversity in usage pattern with the focus exclusively on self-quantification activities. This person claimed to have no “interactive” communication FOMO.

S4 had “Notifications” as the only top category (n=9) with higher frequency, “Usage pattern” and “Usage intensity” are the second most frequent (n=4), the rest have little hits.

S5 reported low usage intensity and low diversity of usage pattern with mostly focus on self-tracking and no notifications, which was reflected in low amount of hits overall. “Usage intensity” is the only top code (n=4), “Usage pattern” and the use of “Pre-installed apps” as well as “Self-tracking” were the others most frequently mentioned (n=3).

S6 revealed medium usage intensity and medium usage pattern with no notifications from communication applications, reflected in low amount of hits overall. “Frequency of usage” is the top code (n=3). “Self-tracking” and “Health” in particular, “Usage pattern” and “Usage intensity” all share second place (n=2).

S7 communicated high usage intensity and high diversity of usage patterns. However, no code was particularly frequent. The codes “FOMO” and specifically “Checking notifications right away” were most frequently mentioned (n=3) alongside “Use cases”, “Notifications” and “Usage intensity”. All the subcodes have little hits.

S8 shared a clear usage pattern and high intensity of usage and mentioned some indications of SMS and self-tracking FOMO. It is reflected in the most frequently mentioned category "Usage intensity" (n=5), while other codes have low hits. "Notifications" and "Behavior modification" are the top ones (n=3).

Both S10 and S11 have "Use cases" as the most frequent code (n=8, n=6). S12 and S13 have low hits overall.

Lastly, S14 has the most hits for "Notifications" (n=7). "Use cases", "FOMO" and "Self-tracking" are all at the second place (n=4), and "Notifications response" is the third most mentioned (n=3).

Next, code frequency analysis was executed. It has shown that "Usage pattern/ use cases" was the most frequently used code covering 11.3 percent of coded material. "Usage intensity" with 11.1 percent follows very closely behind. "Notifications" with 10.7 percent was in third place. Out of all subcodes, "Frequency of usage" and "Smartwatch in interplay with the smartphone" were on the top with 4.8 percent and 4.0 percent respectively.

The relationship between the codes and their similarity in terms of data use are visualized in the code map depicted in Figure 6. It also shows that the codes "Usage intensity" and "Self-tracking" are found to be the most similar in terms of data use, while the codes "Usage pattern/ use cases" and "Self-tracking" have the highest frequency of links between them (n=19). "Usage pattern/ use cases" and "Notifications" as well as "Notifications" and "FOMO" have similarly high to each other level of frequency of link between them (n=11).

The analysis of code relations that included proximity and intersection analyses confirmed the findings from the data map. Additionally, strong relation between the code "Notifications" and the subcode "Smartwatch in interplay with a smartphone" (proximity n=19). There was also significantly little proximity and intersection throughout all main and subcodes between "Behavior modification" and "Notification" (max. proximity n=10).

To summarize, this section provided the description of the empirical part of the research: interview process and analysis according to the process model of the content-structuring

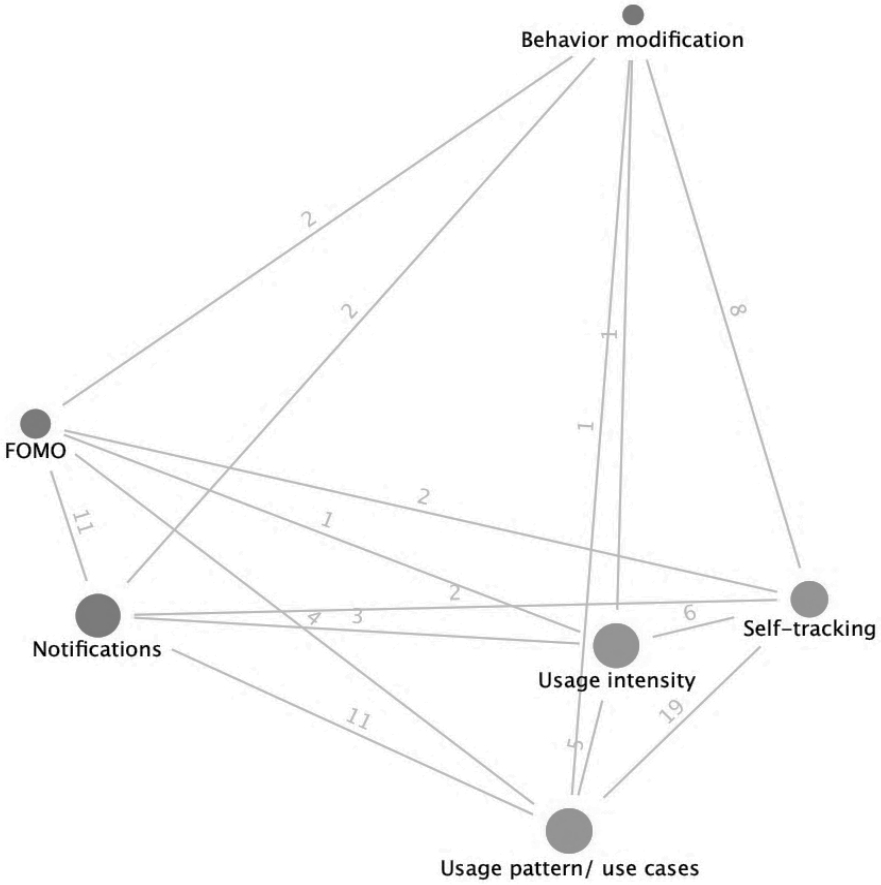

Figure 6. Code map of main categories. The more two codes overlap, i.e., the more similar they are in terms of data use, the closer they are on the map. Size of the figure reflects the frequency of codes in the sample, and the lines show the frequency of links between the codes (reported in numbers).

content analysis. Data collection, coding process as well as several findings deducted by the usage of qualitative analysis tools MAXQDA software provides were described. In the following section the analysis will continue, presenting the first interpretation of the findings.

3.5 Evaluation

The two main parts of the conceptual model were addressed above and namely usage pattern and usage intensity. The goal of this chapter is to go further and not only address the other concepts such as notification management in relationship with smartwatches and self-tracking functionality of these wearable devices but also go beyond the simple description and evaluate the results. Finally, the user interview data in regard with FOMO and their behavior modifications will be put in relation to the other concepts.

The evaluation will be provided based on the summary grid. It was executed as follows. Using all data collected from the interviews and the entire code system, summaries of coded

segments per code were created. Then summaries of the responses of each interviewee were added and finally compiled in a summary per code and speaker. The results are presented below.

On the topic of notifications:

As it is seen from the code map analysis above, the codes “Notifications” and “FOMO” have a significant level of frequency of link between them in the data (n=11) which indicates a high level of connection between these topics. This connection shows that the subject of notifications is therefore highly significant within this research on the interrelationship of FOMO and smartwatch usage. “Notifications” is also the third most frequent code within the analysis, and even though in the conceptual model (Figure 2) notifications are connected to the usage intensity, according to the code map the code “Notifications” is more strongly linked to the “Usage pattern”. Additionally, the following conclusions can be made based on the analysis of the summary grid.

Firstly, the conclusion that can be drawn from the interview data is that notifications on a smartwatch provide an additional step between paying no attention to messages and actively examining them. There is a difference between gazing at the short information notification provides about the message and inspecting the incoming message itself. Notifications on the smartwatch help “filter” what is important. One user put it this way: “before – without the watch – I'd be up and down all the time going to check my phone”, meaning that now the smartwatch takes this away by providing the needed information. Another one described the reaction to the push notification to be “[o]kay, who says what?”.

Secondly, notifications are divided into two main categories depending on what and in what form is being communicated. What is meant by that is that the division in machine-to-human and human-to-human communication. These categories ought to be considered separately when building hypothesis. The examples of the former are the notifications that concern self-tracking, or, for instance, the notifications about payments executed with help of the smartwatch that come to the smartphone. This idea of device ecosystem that acts as a network to increase functionality is a topic of the device relationship within the IoT, discussed in the first chapter and an important characteristic of wearable technology. The latter, human-to-human communication includes an umbrella of now established

communication services such as social media, electronic mails, social platforms, messaging applications and others.

Generally, there is an opinion among respondents that notifications are "the main purpose of having" a smartwatch. One respondent described them as "optimal". However, there is also a tendency to take control and adjust the settings of notifications to fit personal needs. Mostly the intention to limit the notifications is achieved by using some customized settings. This tendency corresponds to earlier findings in the literature that more than half of users were shown to have "turned off at least some notifications after an initial novelty period" (Cecchinato et al. 2017:4).

Several respondents shared having none or barely any notifications altogether or for specific functions of the smartwatch. Some users limit notifications from communication applications and focus on those from self-tracking services – whether for health reasons such as blood sugar level or heart rate control, or just for some fitness motivation. When focusing on communication services notifications, some users put more effort in customization of incoming alerts, making them time-, or application-dependent. The majority of respondents mentioned turning on the "Do not disturb" mode to limit their availability at some point.

Altogether, this leads to the conclusion that notifications do have some nudge and how one respondent put it, a smartwatch is an object one "should pay attention" to.

Users also mention the "haptic instant" (Gilmore 2017:190), discussed in the theoretical part of the paper: "as the notification is directly on your wrist, you get it immediately". You can't put yourself "away". When it comes to fear of missing out on the incoming notifications, the respondents' experience varied. Some indicated to "have this feeling of checking it right away". However, looking at a notification does not necessarily mean they feel like they need to examine the full message or reply. In the responses, the notifications were neither directly linked to the feeling of missing out on something specific nor to the feeling of being in touch, connected or available.

A dominant theme across the answers is the subjective categorization of the notifications in "important" or not, and "urgent" or not. For instance, several speakers expressed the feeling that self-tracking instructions notifications are something to be followed if one has a chance – e.g., to stand up, drink water, meditate etc. At the same time, one respondent shared that the notifications that come per email about self-quantification are not important. While the

criteria of what makes a notification or a message important clearly differs from person to person, this topic refers to the model of availability management, depicted in Figure 1.

Availability management tools mentioned by respondents included the ways to control notifications and the level of their intrusiveness. This corresponds to the second level of the model after the decision to wear the smartwatch. The wear pattern was discussed as a part of usage frequency; therefore, the next steps will be summarized here. In terms of allowing the notifications, over half of respondents claimed to use their smartwatches without sound, only with the vibration on. In the sample there was only one person who thought muted is "unpractical". Several respondents shared examples of situations when they limit their availability by turning on the "Do not disturb" mode, such as sport, periods of concentration in connection to work or just phases when notifications felt overwhelming.

An action on the next level of the model is a response to the incoming notification. It can be described in most cases as a quick "check" of the notification to control who is sending the message and reading just the first two or three words. This glance is the way to establish if the message is important and urgent, that directly leads to the decision whether to check the phone for a full message or to answer.

Several users mentioned "phubbing" with the smartwatch. What is worth mentioning is that they perceived it as a benefit of a smartwatch in comparison to smartphone. Because with the watch the people in their surrounding are less likely to notice them glancing at the screen because they may be just looking at the watch to check time. In literature, "phubbing" has a negative undertone and is investigated in relationship with FOMO (Balta et al. 2020; Chotpitayasunondh and Douglas 2016; Franchina et al. 2018). So, this raises a question whether the positive attitude toward "phubbing" on the smartwatch is an indicator of higher likelihood of FOMO of respondents.

On self-tracking functionality:

As mentioned in the second chapter, self-tracking functionality is a distinctive feature of smartwatches and users' responses support this statement. One speaker described the smartwatch as a "good fitness tracker", another mentioned self-tracking as a reason to purchase smartwatch in the first place. One user indicated that the sport tracking is the most important feature of the smartwatch to the extent that without it they would not wear the device. Users describe the goal of self-quantification as "to track my calories and my activity

in general" as well as "to have track of my weight" and altogether "so I can understand the whole picture of my health".

It can be concluded that self-tracking behavior changes or fluctuates over time. Several respondents mention that in the beginning the usage self-tracking is more intense. Speakers share their experience of taking pauses from intense use and coming back to it. For one respondent, self-tracking usage increased with time, while another reported to almost abandon the feature after the initial interest.

Step count is one of the most frequently mentioned features. Besides that, period tracker, sleep tracker including the recording of sleep phases, and general calories were mentioned most often. Self-tracking, besides fitness notifications informing about today's achievements and nudge to move, includes such reminders as a moment for breath, reminder to wash hands, drink water and others. Besides activity tracking one can oversee such metrics as blood sugar levels and blood oxygen saturation. One can set alarms for high or low blood sugar episodes to stay alert. Blood oxygen and heart rate tracking can be used to identify other health-related issues and send alarms.

Self-tracking is reported to increase one's motivation in achieving fitness goals. Self-tracking motivates users to move more. Users share the opinion that a smartwatch helps one to "become more active, healthier [cis.], to kind of keep your day checked and balanced". While the smartwatch "checks basically every data" of theirs, it is a positive feeling as seeing the data helps to "feel much better and more relaxed". The insights self-tracking provides about everyday habits have "a little kick" when one sees the data. Seeing the results is "satisfying" and gives a "mental boost". Interestingly, several users describe self-tracking as an act of control, even if it is something not physically under their control: one speaker used the phrase "with Vivosmart three I could also control my sleep". Another speaker mentioned in a negative sense that the smartwatch can become a "control device" when it instructs users to do certain actions. For example, the user reported following the instruction to drink water, that became "slightly addictive" to pursue the goal.

There is a social aspect of self-tracking but for majority of users the motivation is mostly intrinsic. Most users mention being aware of the social possibility of the self-tracking, but it being not relevant for them. Some do not use the social aspect of self-tracking at all, some do it irregularly. Only one respondent shared to be using this feature socially in a group of

5-6 people for a long time with the use of some external motivation, thus underlining the value of the feature for this group.

On behavior modifications in result of using a smartwatch:

As it is seen from previous analysis, the usage patterns change over time and intensity fluctuates. This is reflected in the overall behavior changes resulting from the usage. Most respondents report that any change they experienced was especially strong in the beginning of the usage. For instance, one respondent shared that the beginning of the usage self-tracking influenced the amount of their activity. However, later on, they didn't visit this functionality often.

Most behavior modifications reported are due to PI and concern new habits as the result of self-tracking. Speakers shared to notice some changes regarding their diet and physical activity, increased awareness about oneself and one's habits, being conscious of such metrics as heart rate and blood oxygen levels. Health-related notifications such as high and low blood sugar alerts change behavior because one is more immediately informed and is less likely to miss or ignore it.

Other aspects of behavior such as reaching the water drinking target, breathing pause, standing up and the length of hand washing also got changed because of the instructions of the smartwatch. Several respondents shared that they have become more active. Their overall movement increased, not only in regards of sport but also in the amount of general everyday activity. The length of sleep changed due to awareness of sleep phases and schedule. A side effect of this self-awareness due to metrics and motivation provided by smartwatch that some respondents shared was that one gets "upset" if they do not reach the target.

However, some respondents informed that the smartwatch also played a role in altering the response pattern to notifications, specifically in interplay with their smartphone. The adjustment respondents described bases on the availability management model discussed above - smartwatches helps to "filter" the messages by checking the notifications on the watch and deciding whether to reach for the phone.

Additionally, speakers mentioned several behavior alterations that presented irrelevant within this research such as the pattern of commercial purchases that was changed by payment functionality of the smartwatch, or fashion preferences altered as one does not wear any other watches anymore because of the smartwatch.

Finally, the rundown of all relevant statements in regard of the topic of FOMO throughout the analysis is going to be presented.

Altogether, several users described the desire and need to wear and use their smartwatch that fits the concept of FOMO. Multiple users described their experienced discomfort when not having the smartwatch on as they felt like they will be missing out on messages. The smartwatch gives the "confidence of being able to check messages in real time". The following perception that "[i]t feels better when I have it on my wrist" users justified their high usage intensity, for instance, putting the smartwatch on first thing in the morning.

Users did not agree on whether they feel more in touch or always reachable because of the smartwatch. Only the half of the sample indicated that they feel like they are always in touch, available and connected.

While one user, for instance, said they feel always connected another underlined that they are always in touch independently from smartwatch as they are always reachable also on the smartphone. However, another opinion supported by several speakers was being not more in touch with the smartwatch, because looking at notifications is about "checking if it's important right now" and it does not mean one is always available. To reiterate, the idea is that being informed is not the same as being reachable. One user reasoned it by saying that with smartwatches' small screen and limited answer possibilities they can only receive the messages, but it does not mean being connected as the connection part happens when they would reply.

The perception on the feeling of being in touch is likewise ambiguous. It is described as a not "100 percent good feeling", but it has "some attractive moments". The feeling of being in touch is ambiguous as on the one hand, it is "good that I know I have the information and then I can look at it if I want to". Users also find the feeling of always being in touch positive because they can connect with people, for example, who are further away geographically, and have a conversation, and for that you need to answer timely. On the other hand, it can be distracting or overwhelming sometimes. A remedy for that is to "have the power" over devices and set limits, discussed above.

Next, most of the users with their notifications activated mention that they need a "quick check" of the incoming alert. Users describe feeling uneasy because the message may be urgent. Because the notification is directly on the wrist, "[y]ou get it immediately" - one has

the “need” to look at it right away. That again does not mean they will read the whole message nor that they will answer right away. One examines the notifications out of curiosity when feeling haptic nudge, it is “automatic” and comes from the desire to stay “informed”. One user shared that checking the notification helps them distinguish the “urgent” matters and therefore actually reduce the social exchange or time spent online. Feeling the notification on the wrist makes you look at the smartwatch instantly, however, does not mean communicating back right away. Checking notifications brings the understanding of whether the message is “important”. That does not mean that the behavior needs to change in comparison to not having a smartwatch because “when I don't have my watch with me, then I wouldn't not even know (...) that I have a message”, which corresponds to the availability management model suggested above.

Work-, and family- and friends-contexts can be identified in terms of social notifications. They all belong to the social engagement, referring to sharing personal information with the close social environment (Alt 2015:114). Users mention that after the glimpse at the notification the FOMO goes away. When not using a smartwatch, respondents reported that the level of FOMO had increased at first and then decreased later.

In connection to FOMO and its link with self-tracking, one user claims the social aspect of self-tracking has less effect on FOMO in comparison to the motivational aspect of the smartwatch itself. Others mention that smartwatch “gives a sense of calm” through the knowledge acquired through self-tracking. One user shared that not doing enough workout makes them feel bad, which can be an effect of FOMO.

To sum up, this section provided the first interpretation of the data gathered in the qualitative content-structuring content analysis. In the following section the findings from the empirical part will be paired with ones from the theoretical part to place the results in a larger context and draw conclusions and consequences.

3.6 Findings

This section consists of an overview of the findings from the empirical part of this research based on the conceptual model developed for this research and with a link to theoretical implications discussed in the chapters above.

Firstly, the findings will be evaluated with the backdrop of the theoretical entities selected in the theoretical part.

As mentioned in the second chapter, FOMO is often studied within SDT. The previous research suggested that individuals with less satisfaction of the basic psychological needs for competence – the capacity to effectively act on the world, autonomy – self-authorship or personal initiative, and relatedness – closeness or connectedness with others, also reported higher levels of FOMO (Przybylski et al. 2013:1847). This statement can be confirmed by the empirical findings from the interview data. The data shows that the diversity of the usage patterns as well as the usage intensity are on the one hand, tightly interconnected, and on the other hand, the most discussed topics of the interviews (codes combined covering 22.4 percent of all data) and therefore most relevant for the FOMO research. The usage that drives these two factors consists of the six main functions identified in Figure 5: communication applications, self-tracking and the functionality that is unrelated to FOMO, such as timekeeping and payment functionality, remote control and tandem with other devices. Therefore, the question arises: what needs are behind these use cases? The respondents frequently state the need to stay "informed" about the "important" matters they may receive messages about. This need of competence and in a way, leadership, is described as the "confidence of being able to check messages in real time". At the same time, as smartwatch helps users "become more active, healthier [cis.], to kind of keep your day checked and balanced", they feel the satisfaction and a "mental boost" by seeing the biodata collected by the smartwatch. The need for the autonomy is exemplified by the statement that it is "good that I know I have the information and then I can look at it if I want to". When messaging in a work-related context was brought up several times, the interviewees tended to categorize it as "important" issues. Therefore, being in touch with the help of a smartwatch is seen as beneficial, sometimes even turning to such behavior as "phubbing", as it is less noticeable on the watch in comparison to a smartphone. The speakers also repeatedly mention the need to create closeness by contacting friends and relatives and replying in timely manner. This refers not only to traditional messaging services but also, for example, to the social aspect of self-tracking, mentioned by some of the users.

The negative link this kind of basic needs driven usage has to FOMO can be seen from the Code Map analysis that showed the high connection between notifications and FOMO. It is also illustrated by such statements that the smartwatch can become a "control device" by giving users instructions in the context of self-quantifying applications. One user even described the goal of reaching the drank water target as "slightly addictive". Another said that they get "upset" if they don't reach the target.

When studying the Internet Use Disorder in FOMO research against the backdrop of the I-PACE model FOMO is hypothesized as a predisposing factor to develop unhealthy use of certain Internet applications or sites (Rozgonjuk et al. 2020:2). However, these analyses ignored the interaction with the device itself, as devices in a connected ecosystem provide certain nudge apart from communication and messaging services. Reminders and alerts coming from self-tracking applications of the wearables, and in case of smartwatches vibrating or signaling in some other way directly on the user's wrist, can lead to a comparably unhealthy pattern of behavior and following rumination (possibly either provoked or strengthened by FOMO) as interactive applications mentioned withing this model. The smartwatch functionality that includes vibrating alerts and way of use – on the wrist – create a haptic nudge, frequently mentioned by users. They describe the process of looking at the notifications as "automatic", as one can't put themself "away" from it. At the same time, on the topic of behavior modification in result of using a smartwatch, respondents' answers mostly concern changes related to self-tracking activities. The speakers claimed to have changes in their diet and the amount of physical activity as well as increased awareness about oneself and one's habits as a result of biodata collection by the smartwatch. These changes do not mean that the smartwatch usage only has negative consequences. This is simply an illustration of another step in the communication models enabled by the IoT and namely machine-to-human communication. The data also shows that users may feel bad or "upset" when not doing enough workout or not reaching some other self-tracking targets. Meaning users not only do not want to miss out on the notifications from the self-tracking applications but also on achieving the results these applications set them as a goal.

In regards of CIUT, the following aspects of compensatory use are of special interest within this research: within CIUT it is described that the compensatory use can then have positive and negative outcomes. Positive in the sense that the individual feels better because they get the desired social stimulation and negative because this mechanism can turn into a vicious circle where the offline social interaction will gradually reduce or even disappear, leaving the user dependent solely on the internet for social stimulation (Kardefelt-Winther 2014:352). The effect that can be deducted from the data is that FOMO, if conceptualized in a simple way as a state of anxiety of not knowing or not being available/reachable then smartwatch reduces it. Users justified their high level of usage intensity by saying that "[i]t feels better when I have it on my wrist". This is due to the fact that one can get the desired

social stimulation mentioned in CIUT right away. During the coding process a code "After checking no FOMO" was created and was later merged with "Checking notifications immediately", that included statements on how users experienced satisfaction and ease after checking the notifications on the smartwatch. The extra step smartwatches provide described in the availability management section above – the quick glance at the alert that notifies about the incoming message – is the one that makes individuals feel better as they feel "informed", sometimes in touch and in control of what is important. This quick "check" of the short information, who is texting and sometimes just the first two or three words, reduces the fear to miss out on the information. Obviously, the fear to miss out on something mentioned in the message is a different case that is not simple to study.

The negative effects of this behavior are firstly, the dependency of users on the device, and secondly, their possible falling out in a current social situation offline, as proposed in CUIT. The former is described by the users as the intrusive thoughts that without the smartwatch they know they are missing messages that are coming to the smartphone they have no access to. The smartwatch takes away the need to "be up and down all the time going to check my phone", and without it the participants mention FOMO increasing. This effect is also perceptible if one makes a longer pause in smartwatch usage – one user described initial increase of the discomfort with later decrease. Whether the final state constituted of higher or lower absolute level of FOMO is unclear. The latter is represented by negative behaviors users turn to due to the need to get the "kick" of either tending to online socialization or following the instructions given by the wearable device. As an example, "phubbing" on a smartwatch in contrast to on smartphone is reportedly perceived less negatively by some users as the people around will less likely notice. However, one user mentioned this behavior and claimed that it is still visible and feels uncomfortable. This may lead to eventual falling out from the offline social circle in the same way as with a smartphone and have negative long-term effects. A similar example can be brought regarding the self-tracking functions. As several users mentioned, the notifications from the self-tracking applications are something one "should pay attention" to. Most of them claimed to not follow the instructions in the situations it is inappropriate (such as standing up to reach the standing target in unsuitable surroundings such as library or during work). And while following these instructions to meditate, drink water or reach movement goal may not directly lead to the suspension of social relationships, it may provide a substitute to some and eventually end up

decreasing social contacts. Following the machine-communicated fitness targets can give a rewarding experience and make one less interested in social aspects of these activities.

Secondly, the findings will be discussed to critically evaluate the conceptual model (Figure 2) created for this research.

Several statements can be made on applicability of the conceptual model. Firstly, the conceptual model gave a solid structure to the empirical part of the paper as it was based on the theoretical findings. According to both SDT and CUIT, personal characteristics shape the way users engaged with their smartwatch and with what patterns. This can be seen on how diverse described usage patterns are and the level of engagement. Some users reported to be wearing the watch every day but taking it off at night, some had specific days or occasions to use the smartwatch, some used it every day and then slept in it. Finally, some users stopped using it after some time. The use cases were also individual according to the needs users had. Personal characteristics also influenced the level and intensity of FOMO as well as the abilities to "take control" over the device. The self-tracking feature of smartwatch as a unique trait of wearable technology is a part of usage pattern which is proven by the high frequency of links (n=19) between these notions.

Secondly, however, as discovered throughout the analysis above, some relations between the entities of the model were conceptualized imprecisely. For example, while in the model the notification response is connected to the usage intensity, according to the interview data analysis and namely the code map "Notifications" are more strongly linked to the "Usage pattern". It has also not been clearly identified that FOMO has a mediating effect between the usage pattern and the usage intensity.

Finally, it was determined that the model is incomplete in some aspect. One of such findings is that besides the usage pattern and usage intensity, the availability management plays a big role in regulation of interactions. Conceptually, the availability management can be viewed as a part of either the notification response or of the usage pattern and therefore added to the model. Thus, it can be summarized that the conceptual model created for this research has proved to be useful but not complete as there are more factors at play in the relationship between FOMO and smartwatch usage.

Finally, based on the conducted analysis, the research questions are going to be attended to and following deductions will be made to present the findings in a condensed form.

RQ1: What is the relationship between smartwatch usage and FOMO?

As established from the analysis conducted in the theoretical part of the study, the FOMO concept can be applied to smartwatches if the devices are used in their full potential. The three theoretical entities chosen as a background to investigate FOMO have proven their efficiency and the scales developed to measure FOMO could be applied to measure FOMO in relation to smartwatches. Additionally, the FOMO concept was widened by adding a new dimension of machine-to-human communication to the mix of the information one could possibly miss out on.

Based on the interview data collected in the empirical part, smartwatch usage has several links to FOMO. The feature most closely related to FOMO is message notifications, where a smartwatch broadens users' response options to manage availability. If FOMO is seen as a state of anxiety of not knowing what others are doing or not being available for a conversation, then smartwatch reduces it. FOMO connects to the desire to "be informed" and with the smartwatch it is achieved by short "glimpses". Users also claim a smartwatch "gives a sense of calm" with the data acquired through self-tracking applications.

RQ2: What is smartwatch-users' specific response pattern behavior in relation to FOMO of notifications?

Derived from the empirical research conducted within this study, there are four main types of FOMO in relation to smartwatches that can be suggested as a new classification. They are depicted in Table 4.

Table 4. Four main types of FOMO identified in relationship to smartwatches

Types of FOMO	Description
No FOMO	Type of usage not characterized by any FOMO related behaviors.
Machine FOMO	FOMO of notifications from the smartwatch. Feeling bad about not working out or reaching targets.
Social FOMO	The traditional definition of FOMO discussed in the theoretical chapter.
All-FOMO	Combination of both types of FOMO, characterized by high usage intensity and diverse usage patterns.

"No FOMO" is a type of usage that neither is provoked nor leads to any of FOMO related effects. "Machine FOMO" is the additional dimension of FOMO that comes from the unease or unwillingness to miss out on the alerts communicating self-tracking messages, such as

movement instructions or biodata reports. It is characterized by positive feelings when engaging with such applications and activities and negative emotions when not reaching the target. “Social FOMO” is the take on traditional definition of FOMO from previous literature. “All-FOMO” is a construct combining the two types of FOMO including Social FOMO in a traditional understanding and FOMO of device alerts.

RQ3: How does self-tracking effect FOMO?

Beside the addition of machine-to-human interaction SQ offers, the following statements can be derived. Self-tracking functionality is an important feature that is unique to wearable devices in the extend they provide it. Even though FOMO is a social phenomenon, self-tracking activates it in a wearable-specific manner: these notifications are more likely to be followed as instructions, to increase motivation and have an impact on users’ wellbeing. Based on the empirical research, self-tracking applications are the ones that are most likely to influence and change users’ behavior due to it being “slightly addictive” to pursue the goal.

4 Conclusion

In this chapter the results of both theoretical and empirical research are summarized. Then the findings are considered from a variety of perspectives, and conclusions and contributions of the paper are discussed. Recommendations for action are summarized both for users and designers as well as on systematic level of how technology is approached. Finally, limitations of the paper and an outlook on further research is given.

The present paper provides an empirical examination of the fear of missing out, a psychological phenomenon with social nature, in relation to wearable devices in Viennese residents. The relevance of the topic is proven by the widespread of technology connected to FOMO, as out of total population of 9.2 million people in Austria there were about 8.2 million internet users and 7.4 million social media users in January 2022 (We Are Social; Hootsuite; DataReportal 2022:n.a.). As it was mentioned above, the wearable technology is also having a steady growth and conquering its position on the market. At the same time, the direct and indirect effects of FOMO are concerning general well-being (Alt and Boniel-Nissim 2018:35), as well as the stress levels in connection to social media usage (Beyens et al. 2016:6) and after all physical, emotional and cognitive health (Baker et al. 2016:280), to

name a few. The introductory chapter established that in the literature, FOMO is seen as an "informative metric" (Baker et al. 2016:280) about one's relationship with technology and social media, and therefore it is highly relevant to keep driving the continuous research in this area forward.

The present paper provides several important contributions in academic understanding of the FOMO concept. By suggesting that FOMO can be applied on devices other than a smartphone and outside of traditional interactive communication patterns that were in focus of previous research, this paper widens the concept by adding another dimension to the FOMO concept and namely FOMO in machine-to-human communication. Successively, by broadening the frame of reference, this paper opens a new viewpoint in the topic of Internet Use Disorder. Another contribution is the creation of the classification of types of FOMO, that can be broadened in further research and the formulation of the conceptual model in an attempt to structure the interplay smartwatch usage has with FOMO based on the theoretical entities used to study the concept and state of research on each of the topics.

Several questions arose after this research.

What are the other factors that may contribute to the interplay between smartwatch use and FOMO? This topic can be divided in two parts, first being: does ownership of wearables increase the tendency to develop FOMO?

In line with the suggestion in the literature that FOMO and problematic use have a bidirectional effect and neither is causality of the other (Lo Coco et al. 2020:5), the following two statements can be made. The link between FOMO and smartwatch usage is seen at the first stage of the availability management model as people allow notifications likely because they want to be informed. Besides that, the smartwatch usage is likely to drive FOMO because the haptic nudge forces one to "automatically" look at the wrist and smartwatches widen the palette of the incoming notifications, for instance, by including machine-to-human notifications from health and fitness tracking applications.

The second part of the overarching question can be formulated as follows: what contribution does the increasing variety of devices make to the strengthening of FOMO? This question opens new possibilities for future research. Some additional suggestions will be made in the section below.

To sum up, this paper succeeded in the set objective of studying the relationship between smartwatches as an example of wearable devices and the fear of missing out. For that, the concept developed primarily in relation to social media usage on smartphones was critically analyzed in order to establish whether it can be applied to smartwatch usage and then empirically researched based on a conceptual model. As announced in the beginning of the paper, the research contributes by providing an empirical work regarding wearables and specifically smartwatches, deepening the topic of FOMO on different devices, opening new areas for further research and discussion as well as drawing attention of both designers and users to the problem.

4.1 Recommendations for Action

On systematic level, the topic of this paper underlines the importance of media literacy in the society. The FOMO research often focuses on the adolescents as the outcomes of FOMO can be more severe due to adolescents' vulnerability. The change of surrounding that comes with moving from school to college, increased levels of stress and other factors can contribute to a higher level of unsatisfied basic needs within SDT and drive higher compensatory use within CUIT. At the same time, younger audience is more open and acceptant of the new technology such as wearables. Educating young adults about the appropriate use of the technology, means to regulate the interaction and the ways to cope with sometimes overwhelming information will provide them with guidelines that can help improve their well-being and contribute positively to their resistance towards FOMO and its effects.

For designers, it would be beneficial to work on the factors that contribute to FOMO and may decrease users' well-being and therefore satisfaction. State of the art of the research suggests such methods as intelligent notification management to only let the most important notifications through and reduce the interruptions (Lee et al. 2018:1–7). Concentrating on the interruption reduction, for example, by adopting an opt-in model as opposed to opt-out that became default standard nowadays can improve user experience and therefore indirectly contribute to technology acceptance.

For scientists, some compelling research directions open up based on the present research. Beside the other possible research topics mentioned in suggestion for further research, for example, FOMO-R – FOMO Reduction approach that was mentioned throughout the paper has proven to be the first step towards the creation of a strategy to learn and cope with FOMO

(Alutaybi et al. 2020:22) and can be viewed as a basis for future applied studies in this direction.

For users, this is also a wake-up call to rethink their personal relationship with smart devices and possibly work on media literacy on an individual level. The options modern devices offer in terms of screen time and interruption control are not perfect, however, there are ways to limit the impact the devices have on our everyday lives and "take control" over them.

4.2 Limitations

The limitations of this paper include several aspects that make research on this topic problematic. The following four areas of research were identified as possibly limiting.

Firstly, the construct of FOMO itself is a highly abstract notion on the verge of social and psychological sciences. Even though there are several established definitions of FOMO, it, however, remains to be a concept that is hard to separate from other problematic behaviors. Additionally, the research on the causalities within FOMO and these problematic behaviors is still unclear about their relationship. Besides, it is a negative phenomenon connected to one's behaviors and habits and requires a high level of self-reflection to be studied. These factors make the FOMO concept rather complicated to research both in theoretical and empirical studies.

Secondly, the number of theories that can be applied to study the connection of the concepts that are included in the research is vast. In the theoretical part a review was conducted and two of the most frequently applied theories as well as a model were chosen as a lens for the research. However, this is neither an exhaustive list of the theories the subjects of wearables and FOMO can be studied upon nor are the chosen two theories and the model are a complete representation of the most relevant theoretical base.

Thirdly, as mentioned before, the research was defined for a specific demographic group and namely Viennese residents of all genders between ages 18 and 54 which makes it geographically and age specific as there were found almost no differences between technology expectance of different genders in this area (Statista 2017:n.a.). And while the age limitation was chosen based on the market in this part of the world, focusing on the most tech savvy and active age groups, the location represents just one of the areas in the world and results may differ if data would be collected in other locations. Taking into consideration that Austria and Europe in general are not the leading markets in the number of smartwatches

sold the findings may differ in markets that are more saturated. For instance, in 2021 China alone accounted for a sales share of 24 percent worldwide (Counterpoint Research 2022:n.a.). At the same time, around 30 percent of all smartwatches traded worldwide were sold in North America and only 19 percent in Europe.

Finally, the methodology brings some limitation to the results. As mentioned above, FOMO is a complex construct that is not easily researched empirically. While the methodology used was proven to fulfil the scientific criteria, such applied methods as device data processing, experiments, e.g., supplying non-users with smartwatches to document the change in the behavior and whether it corresponded with the perceived change discovered in this paper could be beneficial and contribute to a deeper understanding of the results. Additionally, such methods as interviews with experts could add value to the theoretical parts of the research and partially counter the limiting effect of focusing on a limited number of theoretical backgrounds, mentioned above. Finally, such research methodology as country comparisons could give a wider comprehension of the results in a worldwide context in opposition to the current research that has its focus on Viennese residents only.

4.3 Research Outlook

By now it is no surprise that the technology market is prognosed to keep its constant and desirably sustainable growth in various areas. Such trends as 5G (fifth generation wireless Internet connection) adoption and cloud technology adoption in software-, platform- or infrastructure are contributing to further development of traditional and IoT devices (Statista 2022d:n.a.). Therefore, the following topics are of interest for further research.

Firstly, where this technology is going. What functions are wearables altogether, and specifically smartwatches, will be able to perform in the future and what segment of usage can it be categorized as. The present research identified six main use cases for smartwatches (Figure 5). This is supported by the categorizations the smartwatches are put into, such as digital fitness & well-being devices, digital health devices and more generally consumer mobile devices (Statista 2022a:n.a., 2022c:n.a.). However, with the new functions and new use applications the devices will play another role in users' lives and have a different relationship to FOMO.

Secondly, connected to this is the question of what importance is there to the confounding factors. To name a few, such factors as emotional intelligence, media literacy, and cultural

differences that mentally program human mind (Hofstede Insights 2022:n.a.) can play a role in the ways smartwatch users experience FOMO.

Thirdly, the ethical perspective on the usage of wearables and FOMO could bring value to the findings in this area. FOMO has proven to have effects that can be abused for personal and commercial purposes. Therefore, the research either on consumer or institutional level concerning designing choices would bring valuable insights into the topic and open a new discussion within media ethics.

Finally, as mentioned above, there are further methods that would bring valuable contribution to the research such as: structured expert interviews, country comparisons, field experiments and biodata collection and interpretations.

To sum up, the problem has proven to be complex and multidimensional and the further research is required.

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Attachment

Exposé Master Thesis 1st submission

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Submission date	30.11.2021
Supervisor	FH-Prof. Mag. Dr. Tassilo Pellegrini
Title	**The Influence of Wearables on FOMO on the Example of Smartwatches**
Research objective	**Problem definition:** Fear of missing out, or FOMO, is "a pervasive apprehension that others might be having rewarding experiences from which one is absent, FOMO is characterized by the desire to stay continually connected with what others are doing" (Przybylski et al., 2013, p.1841). Fear of missing out is linked to excessive and problematic Internet usage, social network services usage and other addictive behaviors that have an impact on concentration, resulting in distracted and less focused daily experience, impairing attention, interrupting school or work and other life activities (Elhai, Yang and Montag, 2020, p.204). And while "[i]t is not yet clear whether FOMO causes negative affectivity, whether negative affectivity causes FOMO, or whether there is a bidirectional effect", FOMO "has been linked to the personality trait of neuroticism, one of the most well-known risk factors for developing a mood disorder. Furthermore, narcissism likely plays a role in FOMO" (Elhai, Yang and Montag, 2020, p.206). The topic is furthermore problematic due to adaption of marketing strategies that co-opted and successfully utilized FOMO in commercial advertising appeals to initiate sales (Hodkinson, 2016, p.65). **Research objective:** Find out what influence smartwatches have on the well-being of users in regard of the outcome on the fear of missing out. In previous research, FOMO is investigated in connection with staying in touch with help of smartphones, however, smartwatches enable the same connectivity even closer – on a "haptic instant" (Gilmore, 2016, p.191). Meaning that social media applications as well as self-tracking applications are directly available, and notifications are physically nudging to engage. The goal is to investigate the impact of this type of wearable technology on fear of missing out. **Key questions:** What effects do smartwatches have on the well-being of users in regard of fear of missing out? What is the relationship of smartwatches, that conceptually and perceptually lie in between a watch and a smartphone (Ha et al., 2017, p.1272), on fear of missing out? How do people react to social media notifications on a smartwatch? Is there a greater desire to check and respond immediately? Do they use build-in application instruments to set boundaries? What role do social media and application metrics play in this? Does fear of missing out increase with the desire to instantly engage or decrease because there is no way to miss out?

Scientific and practical relevance	**Scientific relevance:** While the interplay of smartphones and social media services with FOMO is an acute topic in the recent years (e.g., Wolniewicz et al., 2018, Blackwell et al., 2017), the interrelation between wearable technologies and FOMO is hardly explored. Due to little to no studies in this area, that combine "haptic instant" (Gilmore, 2016, p.191) of smartwatch notifications and problematic outcomes of FOMO, there is a great need for scientific research. Following subjects from the study program serve as the basis for this research: Digital Media & Convergence Management; Digital Commerce: Service Orientation & Customer Experience; Innovation & Business Development. **Practical relevance:** The relevance of the topic consists of the widespread of wearable technology on the one hand - according to Statista Digital Market Outlook, around 880.000 Austrians used fitness wearables in 2020 (Statista, 2021a, n.p.), and around 420.000 were smartwatch users specifically (Statista, 2021b, n.p.). On the other hand, fear of missing out is connected to such significant factors as social media addiction (e.g., Blackwell et al., 2017) and consequently through the compulsory social media use to social media fatigue, which later result in elevated anxiety and depression (e.g., Dhir et al., 2018). It is therefore of great practical importance to ascertain the interconnection of use of this wearable technology and fear of missing out.
Structure	***Table of contents master thesis*** – *Declaration on honor* – *Table of contents* – *Abstract / summary* – *List of figures / list of tables / list of abbreviations* 1 Introduction 1.1 Problem 1.2 Deriving the research question 1.3 Objective and method of work 1.4 Structure of the thesis 2 State of research 2.1 Wearable technology 2.2 Self-tracking 2.3 FOMO 3 Smartwatch usage & FOMO 3.1 Definitions smartwatch vs. fitness-tracker 3.2 Privacy Paradox 3.3 Definitions FOMO vs. problematic social media use 4 Empirical research 4.1 Research question and hypotheses 4.2 Method and instrument 4.3 Results / evaluation 4.4 Recommendations for action 5 Conclusion 5.1 Conclusion results and survey method 5.2 Limitations 5.3 Research outlook

<table>
<tr><td></td><td>6 Bibliography
Attachment</td></tr>
<tr><td>Methods</td><td>Empirical methods:
Method-mix, including:
Qualitative: Hypotheses-generating structured interviews with smartwatch users.
Quantitative: Online-questionnaire (CAWI) based on fear of missing out scale (Przybylski et al., 2013, p. 1847), possibly adjusted with the findings from the interviews, to prove the hypotheses.

Argumentation:
The goal of this research is to measure the effects of smartwatches on fear of missing out. This requires a large number of cases to determine statistical relationships. The research should meet the quality criteria of objectivity, reliability, and validity. The aim of this survey can therefore only be achieved through quantitative research. However, because quantitative research is limited in terms of hypothesis generation (Jensen, 2021, p. 256-258), in sake of validity of this research, the methods will be expanded by qualitative interviews.
In order to generate the hypotheses, qualitative interviews with following data analysis and interpretation will be executed (Jensen, 2021, p.298). Because the topic of the analysis is rooted in participants' perception of the wearable technology, the effect of social desirability is less likely to occur and will be a part of natural setting and following interpretation (Jensen, 2021, p.287).

Population:
In the framework of this research, the focus will lie on all residents of Vienna, Austria between the ages of 18 and 54. This is determined by the distribution of users of wearables.
According to Statista Digital Market Outlook, around 29.8% of users of wearables and fitness apps in Austria were between 25 and 34 years old in 2018 (Statista, 2020, n.p.). 23.3% were between 35 and 44 years old and 20.1% were between 18 and 24 years of age. The last big cohort of users and namely 16.8% were between ages 45 and 54. For this research these four cohorts will be analyzed. According to Statistik Austria, this covers 516.391 females and 518.026 males (Statistik Austria, 2021, n.p.), which makes altogether about 1.03M people.

Questionnaire (CAWI) sample:
The questionnaire sample should be made by means of a conscious, randomized selection in order to represent the population using the characteristics of age, state (Vienna) and gender. The sample will be achieved by a combination of quota and snowball sampling.

<table>
<tr><th>Cohorts</th><th>Males</th><th>Females</th><th>Users</th><th>Sum of the cohort</th></tr>
<tr><td>18-24 y.o.</td><td>16</td><td>17</td><td>23</td><td>32 particip.</td></tr>
<tr><td>25-34 y.o.</td><td>30</td><td>31</td><td>32</td><td>61 particip.</td></tr>
<tr><td>35-44 y.o.</td><td>26</td><td>27</td><td>26</td><td>54 particip.</td></tr>
<tr><td>45-54 y.o.</td><td>26</td><td>27</td><td>19</td><td>53 particip.</td></tr>
</table>

The sample quote shows a desired distribution across the four cohorts. Altogether it is planned to survey 200 people from Vienna, Austria, and around 50% of them are supposed to be smartwatch users.</td></tr>
<tr><td>Literature</td><td>Blackwell, D., Leaman, C., Tramposch, R., Osborne, C. and Liss, M. (2017). Extraversion, neuroticism, attachment style and fear of missing out as predictors of social media use and addiction. Personality and Individual Differences, 116, pp.69–72.</td></tr>
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Additional	

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